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U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU
CHARLES F. MARVIN, Chief

MONTHLY U.S. WEATHER REVIEW

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The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but the publication of contributions is not to be construed as official approval of the views expressed.

ECONOMIES IN PRINTING.

Contributions intended for publication in the REVIEW must in all cases conform to the regulations of the Department of Agriculture with respect to effecting economies in the public printing. The following memorandum in regard to preparing manuscripts for publication has just been issued by the Department.

It is reproduced below for the information of all concerned.

☞ Authors will be expected to prepare their manuscripts, with the understanding that once the manuscript leaves the author's hands it is in final form and not subject to further changes of text in galley or page proof. With the adoption of this policy it will be necessary that authors consult workers on related subjects in other Bureaus before finally submitting their manuscript for publication, and all matters as to which there is difference of opinion must be settled in advance.

BACK NUMBERS OF THE REVIEW WANTED.

The Weather Bureau has not enough of the following numbers of the MONTHLY WEATHER REVIEW to meet even urgent requests for filling up files at institutions where the REVIEW is constantly being referred to. The return of any of these or of any 1919 or 1920 issues, especially November, 1919, will be greatly appreciated. An addressed franked slip may be had on application to the Chief, U. S. Weather Bureau, Washington, D. C.

1914: January, February, March, April, September, October, December.
1915: May, June, July, August.
1916: January, August.
1917: June.
1918: February, September.
1919: Any issue, especially November.
1920: Any issue, especially January.
SUPPLEMENT, No. 3.

MONTHLY WEATHER REVIEW

ALFRED J. HENRY, Editor.

VOL. 49, No. 8.
W. B. No. 750.

AUGUST, 1921.

CLOSED Oct. 3, 1921
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EXCESSIVE PRECIPITATION IN ARKANSAS.

BY H. S. COLE, Meteorologist.

[Weather Bureau, Little Rock, Ark., Sept. 6, 1921.]

SYNOPSIS.

The following article is based upon all excessive precipitation records at Bentonville, Fort Smith, and Little Rock, the three regular Weather Bureau stations in Arkansas, and at Memphis, Shreveport, and Vicksburg, three near-by stations. Extreme rates, average rates for consecutive five-minute periods, and number of occurrences for different rates and different periods of time are tabulated. Curves are prepared showing these extremes, averages, and number of occurrences, also curves showing the number of tabulations of excessive precipitation by months and curves showing the number of times per year different rates for different periods have occurred. The data and curves are explained in the text.

The following article was prepared to meet the needs of engineers, contractors, agriculturists, and other persons whose business is affected by excessive precipitation.

All records of excessive precipitation at Bentonville, Fort Smith, Little Rock, Memphis, Shreveport, and Vicksburg were used. The data were tabulated and the means, extremes, and the number of times of occurrence determined. Curves were drawn showing the extremes, averages, cumulative amounts, frequency of stated rates in given times and the number of times excessive precipitation occurred at the different stations in the different months.

Precipitation records from automatic instruments at Bentonville are available for the past 15 years, at Fort Smith for 19 years, and at Little Rock for 24 years, covering the central, western, and northwestern portions of the State very well, but there are no other stations in Arkansas with such records. Fortunately, however, Memphis, with a 24-year record, is just across the Mississippi River; Shreveport, with a 19-year record, is 35 miles south of the southwest corner of the State; and Vicksburg, with a 24-year record, is 45 miles south and slightly east of the southeast corner. It is thought that the records of these stations are fairly representative of conditions in Arkansas. The greater portion of the data was obtained from the published reports of the Chief of the Weather Bureau and the MONTHLY WEATHER REVIEW; the data that could not be obtained from these were kindly furnished by the officials in charge of the stations mentioned.

The data used are from tipping-bucket rain-gages, the rainfall being recorded in hundredths of an inch on timed sheets. It may be well to explain that the limit at which precipitation is considered as "excessive" by the Weather Bureau is fixed at 0.25 of an inch or more in five minutes, 0.30 inch in 10 minutes, 0.35 inch in 15 minutes, etc., the limit increasing 0.05 for each successive five minutes. The rate is considered excessive even if it does not equal the rate stated in the first few periods if it equals or exceeds that rate later. The tabulation does not begin until the rate equals 0.05 inch in five minutes and ends as soon as the rate falls below this value unless it falls below for only a short time, then becomes excessive again. Precipitation is also considered excessive when 1 inch occurs in 1 hour or 2.50 inches in 24 hours.

All available excessive precipitation data for the stations mentioned were tabulated in chronological order by months and the amounts for the 5-minute periods up to 60 minutes were determined. The greatest amount for any 5-minute period, 10-minute period, etc., was obtained for each station as shown in Table 1. This table is in the form in which such data are used in the Weather Bureau, but runoff formulæ for small areas and short periods of excessive precipitation require the precipitation in rate per hour instead of amounts that occur in short periods. For this reason the data in Table I and other data except for 24-hour periods were reduced to rate per hour.

The average rate per hour for the consecutive 5-minute periods for the first 60 minutes of the excessive periods was determined, the results being shown in Table 2.

TABLE 1.—*Greatest precipitation ever recorded in 5 minutes, 10 minutes, etc.*

	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.	24 hr.
Bentonville (1906–1920)	0.75	1.20	1.58	1.62	1.72	1.84	1.84	1.99	2.09	2.15	2.23	2.32	2.41	2.73	5.10
Fort Smith (1902–1920)	0.57	0.97	1.14	1.29	1.52	1.73	1.79	1.92	2.01	2.03	2.06	2.31	2.70	2.70	5.14
Little Rock (1897–1920)	0.50	0.82	1.12	1.34	1.62	1.92	2.12	2.23	2.29	2.29	2.42	2.60	2.84	3.23	9.58
Memphis (1897–1920)	0.78	1.01	1.08	1.26	1.39	1.45	1.45	1.57	1.69	1.79	1.97	2.33	2.50	2.84	9.30
Shreveport (1902–1920)	0.59	0.95	1.20	1.54	1.76	2.00	2.23	2.43	2.57	2.72	3.15	3.61	4.34	5.13	8.45
Vicksburg (1897–1920)	0.74	1.10	1.37	1.73	2.02	2.30	2.56	2.68	2.82	2.94	3.11	3.27	3.52	3.94	7.99
Greatest any station	0.78	1.20	1.58	1.73	2.02	2.30	2.56	2.68	2.82	2.94	3.15	3.61	4.34	5.13	9.58

TABLE 2.—*Average rate per hour for consecutive 5-minute periods.*

	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	55 min.	60 min.
Bentonville (1906–1920)	2.16	2.28	1.56	1.44	1.56	1.32	1.32	1.20	1.32	0.96	0.84	0.84
Fort Smith (1902–1920)	1.80	1.92	1.68	1.44	1.20	1.20	0.96	0.96	0.96	0.72	0.84	0.60
Little Rock (1897–1920)	1.80	2.04	1.68	1.56	1.32	1.20	1.08	0.96	1.08	0.96	1.08	0.96
Memphis (1897–1920)	1.68	1.92	1.56	1.20	1.20	1.08	1.08	0.96	0.96	1.08	1.20	0.72
Shreveport (1902–1920)	2.04	2.16	2.02	1.68	1.44	1.20	1.32	1.32	1.32	1.20	1.20	0.72
Vicksburg (1897–1920)	1.92	2.28	1.80	1.56	1.32	1.20	1.20	1.32	1.20	1.08	0.96	0.96
Average six stations	1.92	2.19	1.80	1.56	1.32	1.20	1.20	1.20	1.08	0.96	0.96	0.96

TABLE 3.—*Number of times given rate per hour occurred for 10 minutes, 30 minutes, 1 hour.*

Rate per hour.	Bentonville. Number of times—	Fort Smith. Number of times—		Little Rock. Number of times—		Memphis. Number of times—		Shreveport. Number of times—		Vicksburg. Number of times.	
	1906–1920.	1906–1920.	1902–1920.	1906–1920.	1897–1920.	1906–1920.	1897–1920.	1906–1920.	1902–1920.	1906–1920.	1897–1920.
For 10 minutes:											
6.00	1	0	(0)	0	(0)	1	(1)	0	(0)	3	(4)
4.80	4	1	(1)	0	(0)	1	(1)	6	(6)	4	(7)
3.60	17	5	(7)	11	(20)	6	(10)	32	(38)	33	(50)
2.40	80	45	(52)	65	(105)	45	(84)	108	(138)	125	(193)
1.20	190	153	(181)	247	(370)	222	(333)	266	(349)	356	(556)
For 30 minutes:											
4.00	0	0	(0)	0	(0)	0	(0)	1	(1)	1	(1)
3.60	1	0	(0)	0	(0)	0	(0)	1	(2)	1	(1)
2.80	5	3	(3)	0	(4)	0	(1)	9	(11)	8	(13)
2.00	19	8	(9)	13	(27)	10	(17)	34	(44)	39	(61)
1.20	75	46	(56)	83	(133)	74	(117)	96	(126)	132	(207)
.80	107	85	(103)	147	(219)	124	(192)	143	(192)	194	(294)
For 1 hour:											
3.00	0	0	(0)	0	(0)	0	(0)	1	(1)	1	(1)
2.50	0	0	(0)	0	(0)	0	(0)	1	(2)	1	(3)
2.00	2	3	(3)	1	(4)	0	(0)	6	(9)	5	(8)
1.50	7	6	(6)	5	(10)	6	(7)	16	(22)	25	(36)
1.00	31	15	(18)	31	(53)	20	(37)	45	(64)	62	(99)
.60	80	58	(72)	93	(146)	78	(129)	104	(136)	145	(223)

The number of 10-minute periods with precipitation at the rate of 1.20 inches per hour or more, 2.40 inches per hour or more, etc., was determined, also the number of 30-minute periods with a rate of 0.80 inch or more per hour, 1.20 inches or more per hour, etc., and the number of 60-minute periods with a rate of 0.60 inch or more per hour, 0.80 inch or more, etc., the data being found in Table 3. For the purpose of comparison such data should be for the same period at all stations. The record at Bentonville is for the period 1906 to 1920, so the data at all stations were obtained for that period, the numbers for the entire period at each station being inclosed in parentheses. The number of 24-hour periods with 1 inch or more precipitation, 2 inches or more, etc., was determined as in Table 4. The data for this table are for the 15-year period and for the entire period of record, the latter being in parentheses.

The number of times excessive precipitation was tabulated at the different stations is shown by months in Table 5, the data being for 15 years.

TABLE 4.—*Number of times given rate per 24 hours occurred.*

Rate per 24 hours.	Bentonville. Number of times.	Fort Smith. Number of times.		Little Rock. Number of times.		Memphis. Number of times.		Shreveport. Number of times.		Vicksburg. Number of times.	
	1906–1920	1906–1920	1897–1920	1906–1920	1897–1920	1906–1920	1897–1920	1906–1920	1897–1920	1906–1920	1897–1920
9.00	0	0	(0)	1	(1)	1	(1)	0	(0)	0	(0)
8.00	0	0	(0)	1	(1)	1	(1)	1	(3)	0	(0)
7.00	0	0	(0)	1	(1)	2	(2)	3	(6)	1	(3)
6.00	0	0	(0)	1	(2)	3	(3)	3	(6)	1	(4)
5.00	1	2	(3)	3	(4)	3	(5)	4	(7)	3	(8)
4.00	4	3	(8)	6	(9)	7	(13)	7	(12)	10	(17)
3.00	12	6	(18)	15	(24)	15	(27)	14	(24)	33	(45)
2.00	28	23	(49)	45	(73)	43	(68)	37	(55)	72	(100)
1.00	147	112	(197)	190	(300)	187	(300)	174	(264)	282	(342)

TABLE 5.—*Number of times excessive rate was tabulated, by months (1906 to 1920).*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Bentonville	2	2	1	7	14	19	16	12	13	6	2	0	94
Fort Smith	1	3	2	5	13	12	9	13	10	7	2	0	77
Little Rock	5	2	6	17	11	16	18	20	13	11	7	1	127
Memphis	3	4	4	14	15	14	13	22	14	14	5	2	125
Shreveport	1	3	8	15	20	17	11	20	7	6	5	5	118
Vicksburg	12	10	13	22	9	13	21	17	12	9	7	7	152

TABLE 6.—*Number of occurrences per year.*

Rate per hour.	Bentonville (15 years).	Fort Smith (19 years).	Little Rock (24 years).	Memphis (24 years).	Shreveport (19 years).	Vicksburg (24 years).
10-MINUTE PERIODS.						
6.00	0.07	.00	0.00	0.04	0.00	0.17
4.80	0.27	0.05	0.00	0.04	0.32	0.29
3.60	1.13	0.37	0.08	0.42	2.00	2.08
2.40	5.30	2.70	4.40	3.50	7.30	8.00
1.20	12.70	9.50	15.40	13.90	18.40	23.20
30-MINUTE PERIODS.						
4.00	0.00	0.00	0.00	0.00	0.05	0.04
3.60	0.07	0.00	0.00	0.00	0.11	0.04
2.80	0.33	0.16	0.17	0.04	0.58	0.54
2.00	1.30	0.50	1.10	0.70	2.30	2.50
1.20	5.00	3.00	5.50	4.90	6.60	8.60
0.80	7.10	5.40	9.10	8.00	10.10	12.20
60-MINUTE PERIODS.						
3.00	0.00	0.00	0.00	0.00	0.05	0.04
2.50	0.00	0.00	0.00	0.00	0.11	0.12
2.00	0.13	0.16	0.17	0.00	0.47	0.33
1.50	0.47	0.32	0.42	0.29	1.16	1.50
1.00	2.10	1.00	2.20	1.50	3.40	4.10
0.60	5.30	3.70	6.00	5.30	7.10	9.30
24-HOUR PERIODS.						
Rate per 24 hours.	(15-year.)	(24-year.)	(24-year.)	(24-year.)	(24-year.)	(24-year.)
9.00	0.00	0.00	0.04	0.04	0.00	0.00
8.00	0.00	0.00	0.04	0.04	0.12	0.00
7.00	0.00	0.00	0.04	0.08	0.25	0.12
6.00	0.00	0.00	0.08	0.12	0.25	0.17
5.00	0.07	0.12	0.17	0.21	0.29	0.33
4.00	0.27	0.33	0.38	0.54	0.50	0.71
3.00	0.80	0.08	1.10	1.10	1.10	1.90
2.00	1.90	2.00	3.00	2.80	2.30	4.20
1.00	9.80	8.20	12.50	12.50	11.00	14.20

The average number of occurrences per year of the different rates for the 10-minute, 30-minute, 60-minute, and 24-hour periods at the six stations is shown in Table 6. The table shows the length of record used in each case. As these numbers are averages for the different stations and are not desired so much for comparison as for showing what has occurred during the period of observation, the record for the 24 years was used where available, for a shorter period where necessary.

The data for a number of individual storms from which the greatest rates on record were obtained were converted into rate per hour for use in preparing curves of the first set. The broken lines of this set of curves show the greatest rates of precipitation per hour on record at each of the stations for 5 minutes, 10 minutes, etc., up to 120 minutes. The rates per hour during the storms in which the greatest rates occurred are charted on the axes with the greatest rates on record, solid line curves being used. It will be noted that the curves for the greatest rates on record do not usually coincide with the curves of the storms in which they occur, but that they do usually touch or come near them at some point. Vicksburg is the only station at which the curves coincide for the first five minutes. This is because the greatest rate for five minutes does not usually occur in the first five minutes after the excessive rate begins. When charted in the individual storms the greatest rate for five minutes is combined with the lower rates preceding. The greatest rates for the different periods are not found in any one storm at any station, the short periods being found in one storm, the longer ones in other storms. At Little Rock the greatest rates for the 5, 10, and 15 minute periods are found in the storm of May 29, 1900; those for 20 and 25 minutes occurred on May 21, 1898; those for 30, 35, 40, and 45 minutes on July 11, 1903; those for 50, 55, and 60 minutes, on August 9–10, 1915; for 65 and 70 minutes, May 5, 1907; and for the remainder, on April 9, 1913.

For many purposes the amounts of precipitation in short periods are desirable, and for such cases we have placed an insert in the upper right-hand corner of the rectangles for the first set of curves and have drawn curves for the greatest amounts in 5 minutes, 10 minutes, etc., up to 120 minutes for each of the stations. Such curves are frequently called cumulative or mass curves, and indicate much more plainly the variation in the rate of fall at a given time than curves for rate per hour.

It may be of advantage to know in what portion of the shower the heaviest precipitation has occurred. For this purpose the curves of the second set were prepared from the data in Table 2, showing the average rate per hour for the successive 5-minute periods. These curves show that the rate usually increases rapidly the first 5 minutes, continues high for about 10 minutes, decreases rapidly the next 5 minutes, then decreases slowly until the rate ceases to be excessive. The curve for the data at Bentonville is higher in the first three periods that those at the other stations. This is due to the fact that excessive precipitation at that place nearly always occurs in connection with a thunderstorm of the Plains States type—intense for a few minutes, then over. The surface air becomes intensely heated in summer, causing strong convective currents, which result in the intense thunderstorms of that section; but the moisture of the air is insufficient to build up the extensive thunderstorms, such as occur farther southeast. Moderate precipitation frequently occurs at Fort Smith and Bentonville in winter, but these places are cut off from the easterly to southerly winds to a great extent by the mountains, causing much lighter rainfall at that season than occurs farther southeast.

Remarks on Table 5.—Excessive precipitation was recorded very few times from November to April, none having been recorded at Fort Smith and Bentonville in December. The number of times was large at all stations from April to August, the largest number being 22 times at Memphis and Vicksburg, the former in August, the latter in April. Fort Smith is the only station at which the greatest number of tabulations of excessive precipitation occurs in the month having the greatest monthly precipitation, and at this station data for a longer period changes it to another month.

It is a well-known fact that monthly and annual precipitation increases from northwestern Arkansas toward the southeast, but it is plain from the curves of sets one, two and three[1] that the greatest rates for short intervals do not. The geographic distribution for short intervals is very irregular. The first set of curves shows that the greatest rate for a 5-minute period is 9.36 inches per hour at Memphis; the next greatest, 9 per hour at Bentonville, Vicksburg being third, with 8.88 inches. The greatest rate for a 10-minute period was 7.20 inches per hour at Bentonville, the second highest being 6.66 inches per hour at Vicksburg. The greatest rate for a 30-minute period was 4.60 inches per hour at Vicksburg; the next greatest, 4 inches at Shreveport. If we accept the record at Fort Smith for August 7–8, 1898, before the tipping-bucket record at that place began, the greatest rate on record at that station for one hour is 3.25 inches; Shreveport being a close second, with 3.15 inches; Vicksburg third, with 3.11 inches. Memphis, the station having the greatest rate per hour for five minutes, has the least for one hour, 1.97 inches. The greatest rate per hour for two hours is 2.56 inches at Shreveport, 1.97 inches being recorded at Vicksburg for the same period. The greatest amount for any 24-hour period on record

[1] Third set not reproduced: EDITOR.

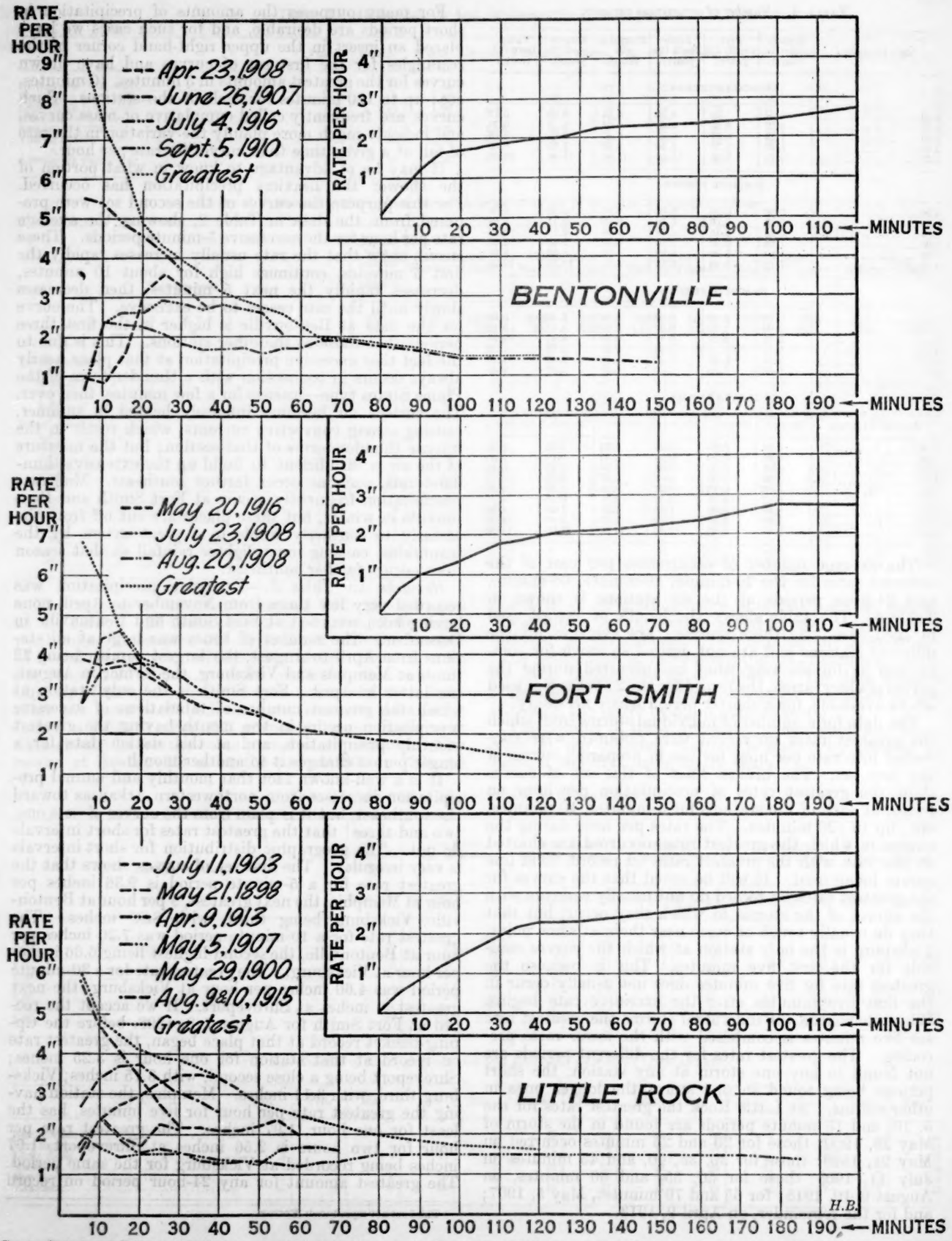


FIG. 1.—Rate of precipitation in individual storms, and greatest rates on record at Bentonville, Fort Smith, and Little Rock, Ark. Insert: Greatest cumulative amounts on record.

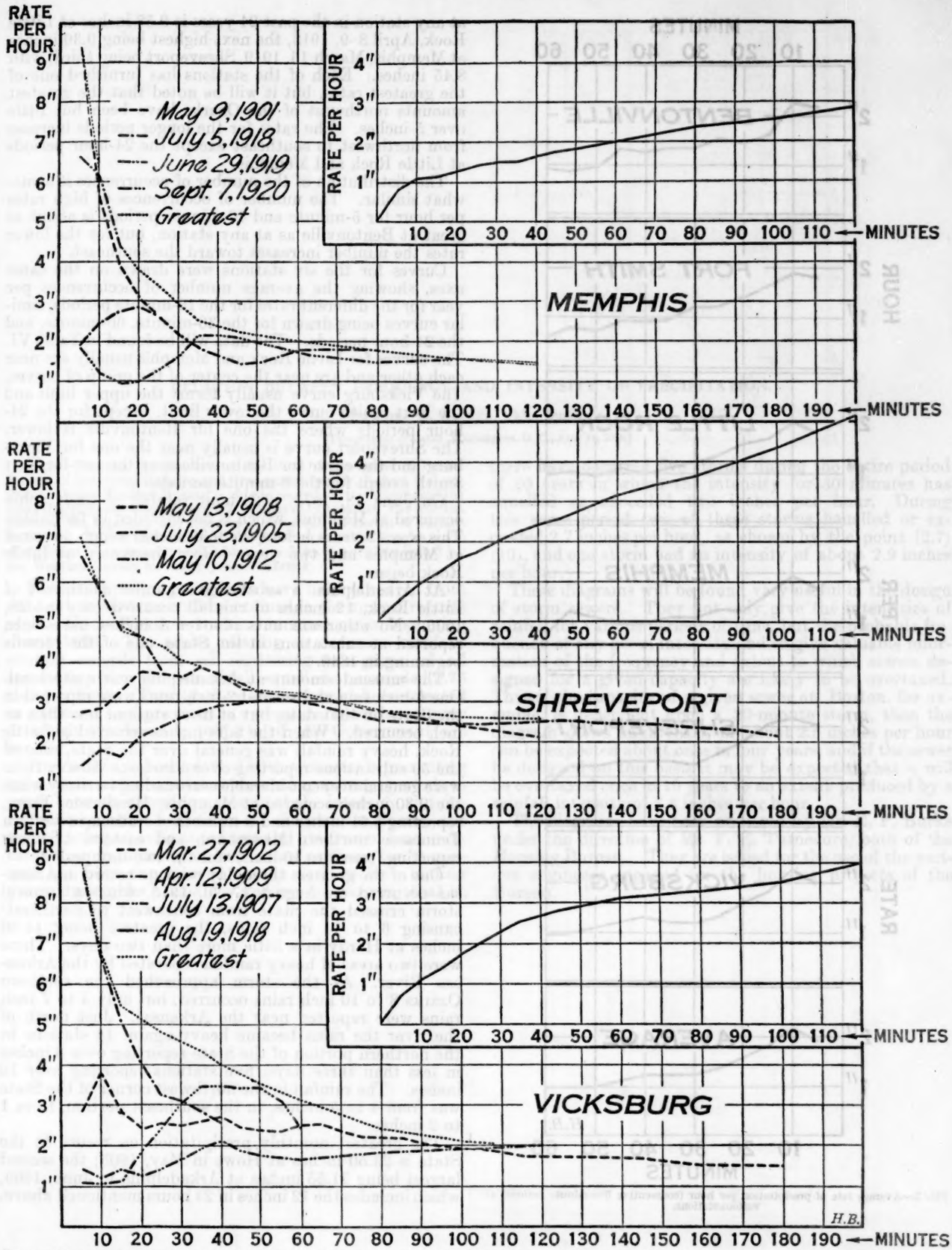


FIG. 2.—Rate of precipitation in individual storms, and greatest rates on record at Memphis, Tenn., Shreveport, La., and Vicksburg, Miss. Insert: Greatest cumulative amounts on record.

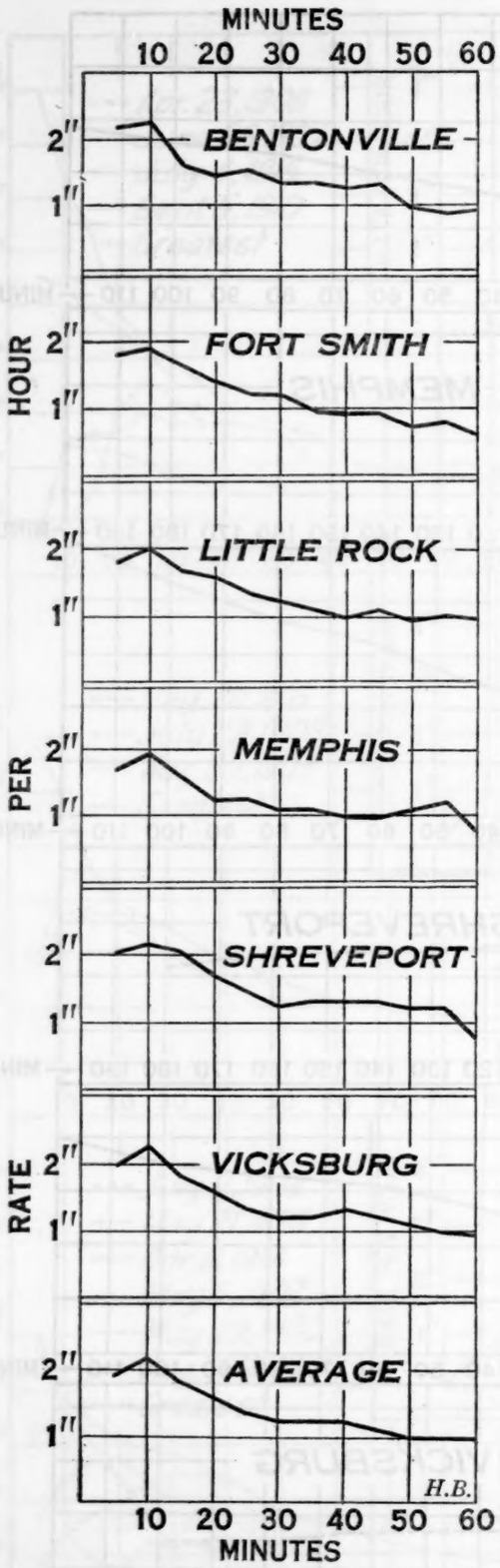


FIG. 3.—Average rate of precipitation per hour (consecutive five-minute periods) at various stations.

at any station in the past 24 years is 9.58 inches at Little Rock, April 8–9, 1913, the next highest being 9.30 inches at Memphis, March 16, 1919, Shreveport being third, with 8.45 inches. Each of the stations has furnished one of the greatest rates, but it will be noted that the greatest amounts northwest of the Ozarks have been but little over 5 inches. The rates for the longer periods increase from northwest to southeast except the 24-hour periods at Little Rock and Memphis.

The distribution of the number of occurrences is somewhat similar. The number of occurrences of high rates per hour for 5-minute and 10-minute periods is about as great at Bentonville as at any station, but for the lower rates the number increases toward the southeast.

Curves for the six stations were drawn on the same axes, showing the average number of occurrences per year for the different rates for the 10-minute periods, similar curves being drawn for the 30-minute, 60-minute, and the 24-hour periods. The data will be found in Table VI. The curves for Little Rock and Memphis usually are near each other and are near the center of the group of curves. The Vicksburg curve usually forms the upper limit and the Fort Smith curve the lower limit, except for the 24-hour periods where the one for Bentonville is lower. The Shreveport curve is usually near the one for Vicksburg and the curve for Bentonville near the one for Fort Smith except for the 5-minute periods.

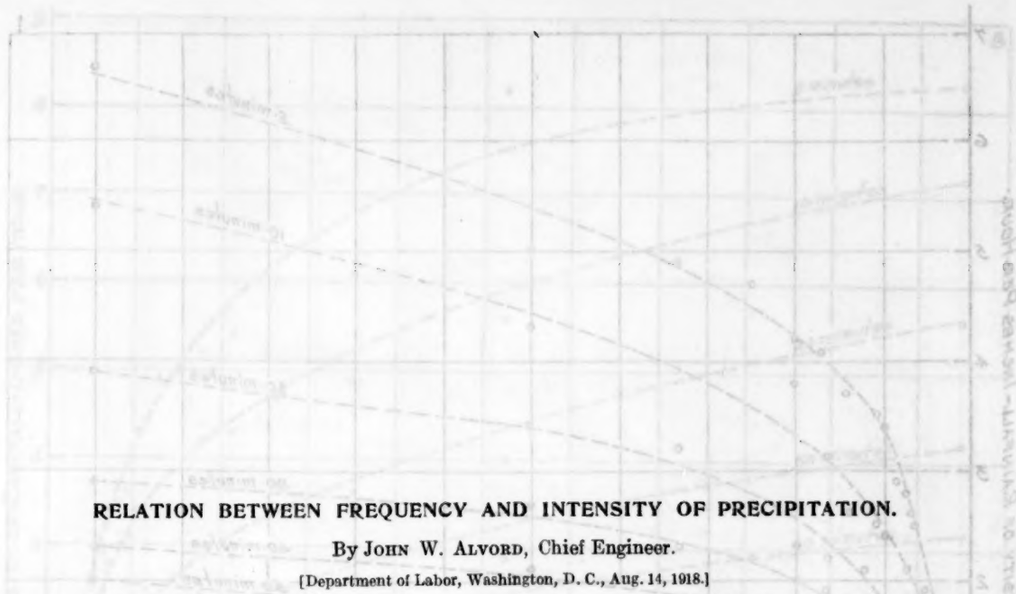
On June 13, 1877, a 24-hour rainfall of 9.67 inches occurred at Memphis, which is not included in the tables. This was 42 years before the 9.30 inches which occurred at Memphis and two years before the record at Little Rock began.

At Arkadelphia, a substation 65 miles southwest of Little Rock, 12 inches of rainfall occurred on June 28, 1905. No other amounts of over 8 inches have been reported at substations in the State, one of the records beginning in 1840.

The unusual amount at Arkadelphia was quite local. One 6-inch rain and several 2-inch rains were reported in the State on that date, but at most stations less than an inch occurred. When the 9.58 inches occurred at Little Rock, heavy rainfall was general over the State, nine of the 59 substations reporting over 4 inches. Heavy rains were general over considerable surrounding territory when the 9.30 inches occurred at Memphis; Henderson, Tenn., reporting 8.61 inches and a number of stations in western Tennessee, northern Mississippi, and eastern Arkansas reporting from 6 to 10 inches for the two-day period.

One of the greatest three-day rains on record in Arkansas occurred on August 17–20, 1915, when a tropical storm crossed the State from southwest to northeast causing 6 to 14 inch rains, the greatest being 14.80 inches at Hardy in a little more than two days. There were two areas of heavy rainfall separated by the Arkansas River. As the storm approached the southern Ozarks 8 to 10 inch rains occurred, but only 4 to 7 inch rains were reported near the Arkansas. Just north of the river the rains became heavy again, 14 stations in the northern portion of the State reporting over 8 inches in less than three days, five stations reporting over 10 inches. The rainfall in the northwest corner of the State was from 4 to 5 inches, in the southeast portion, from 1 to 2 inches.

The greatest monthly precipitation on record in the State is 23.50 inches at Howe in May, 1905; the second largest being 21.55 inches at Arkadelphia in June, 1905, which includes the 12 inches in 24 hours mentioned above.



RELATION BETWEEN FREQUENCY AND INTENSITY OF PRECIPITATION.

By JOHN W. ALVORD, Chief Engineer.

[Department of Labor, Washington, D. C., Aug. 14, 1918.]

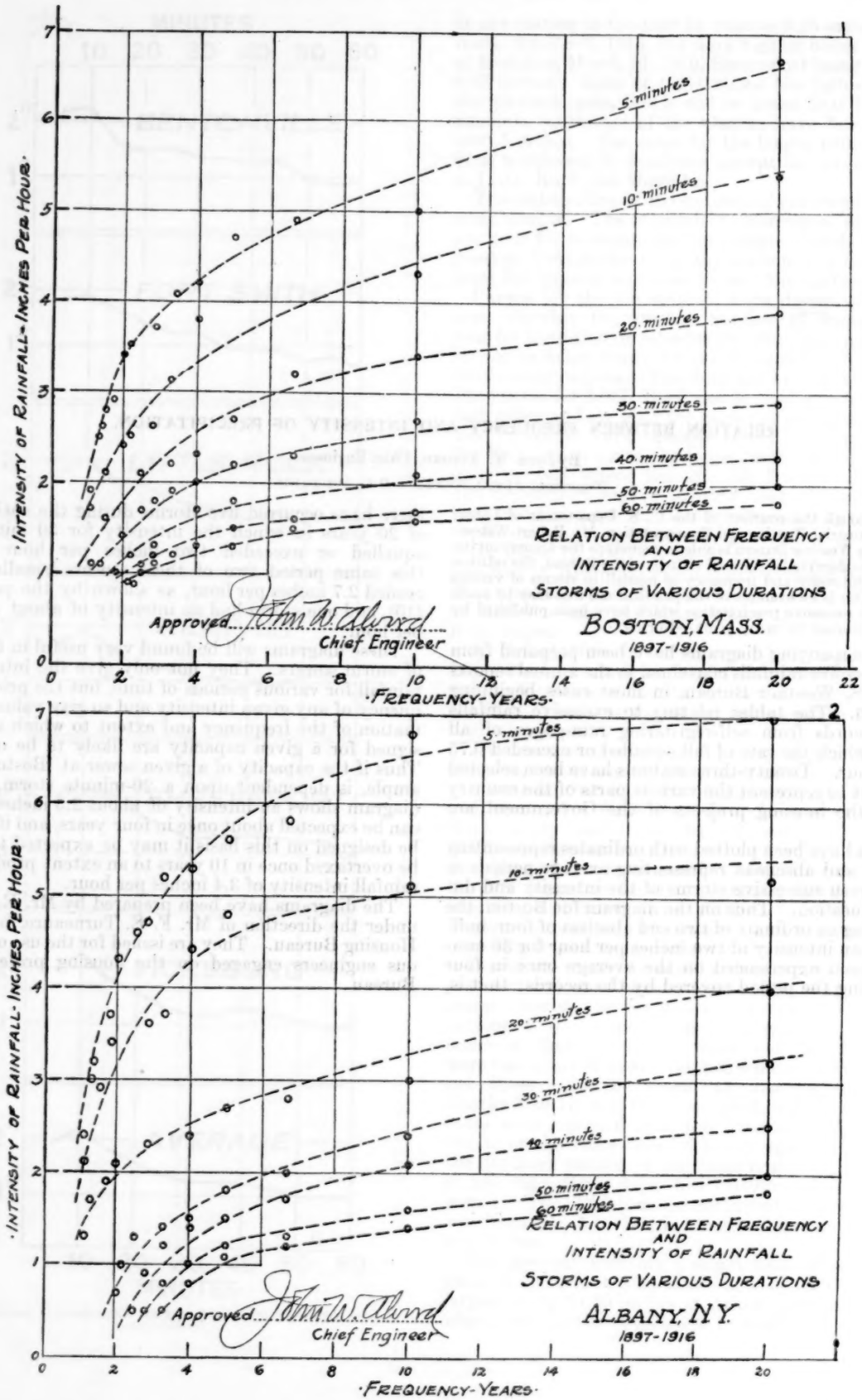
NOTE.—Through the courtesy of the U. S. Department of Labor, Bureau of Industrial Housing and Transportation, Mr. Robert Watson, President, the Weather Bureau is able to reproduce the accompanying set of diagrams showing for selected stations of the Bureau, the relation between the intensity and frequency of rainfall in storms of various durations. This is an example of the practical use that may be made of statistics of excessive precipitation which have been published by the Weather Bureau for many years.—EDITOR.

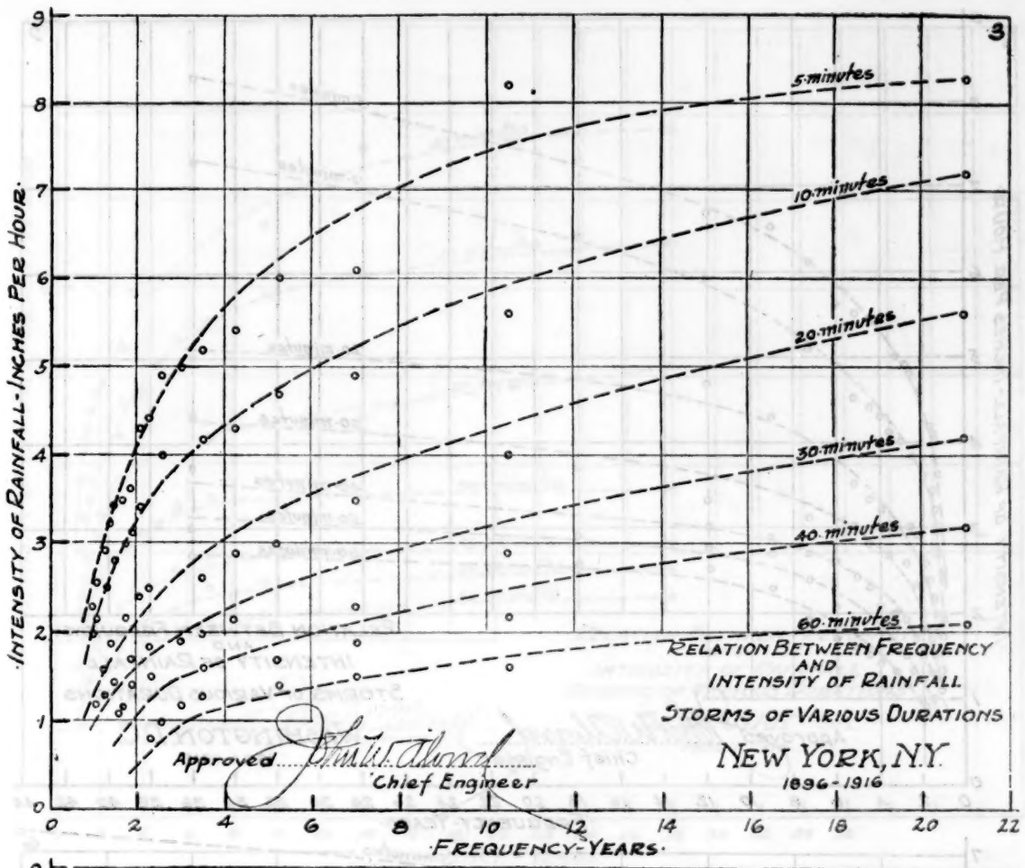
The accompanying diagrams have been prepared from data of excessive rainfalls contained in the annual reports of the U. S. Weather Bureau, in most cases beginning about 1896. The tables relating to excessive rainfalls contain records from self-registering rain-gages of all storms in which the rate of fall equalled or exceeded 0.75 inch per hour. Twenty-three stations have been selected as sufficient to represent the various parts of the country in which the housing projects of the Government are located.

The data have been plotted with ordinates representing intensities and abscissas representing average periods in years between successive storms of the intensity and duration in question. Thus on the diagram for Boston, the point having an ordinate of two and abscissa of four, indicates that an intensity of two inches per hour for 30 minutes has been experienced on the average once in four years, during the period covered by the records; that is, there have occurred five storms during the entire period of 20 years in which the intensity for 30 minutes has equalled or exceeded two inches per hour. During this same period two of these storms boualled or exceeded 2.7 inches per hour, as shown by the point (2.7) (10), and one storm had an intensity of about 2.9 inches per hour.

These diagrams will be found very useful in the design of storm sewers. They not only give the intensities of rainfall for various periods of time, but the probable frequency of any given intensity and so give valuable information of the frequency and extent to which sewers designed for a given capacity are likely to be overtaxed. Thus if the capacity of a given sewer at Boston, for example, is dependent upon a 20-minute storm, then the diagram shows an intensity of about 2.5 inches per hour can be expected about once in four years, and if the sewer be designed on this basis it may be expected that it will be overtaxed once in 10 years to an extent produced by a rainfall intensity of 3.4 inches per hour.

The diagrams have been prepared by Mr. E. P. Burke under the direction of Mr. F. E. Turneaure, both of the Housing Bureau. They are issued for the use of the various engineers engaged on the housing projects of the Bureau.


INTENSITY OF RAINFALL - INCHES PER HOUR.
FREQUENCY-YEARS.
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL
STORMS OF VARIOUS DURATIONS
BOSTON, MASS.
1897-1916
Approved John W. Alvord
Chief Engineer
INTENSITY OF RAINFALL - INCHES PER HOUR.
FREQUENCY-YEARS.
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL
STORMS OF VARIOUS DURATIONS
ALBANY, N.Y.
1897-1916
Approved John W. Alvord
Chief Engineer


3
5 minutes
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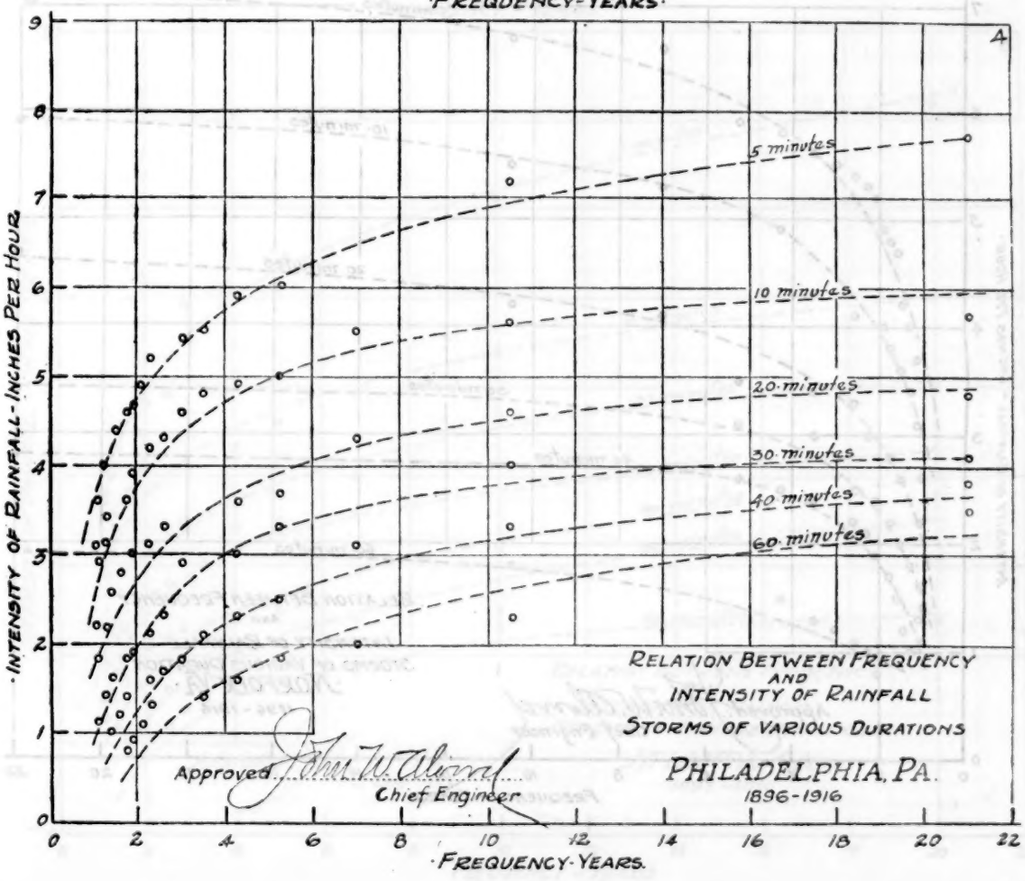
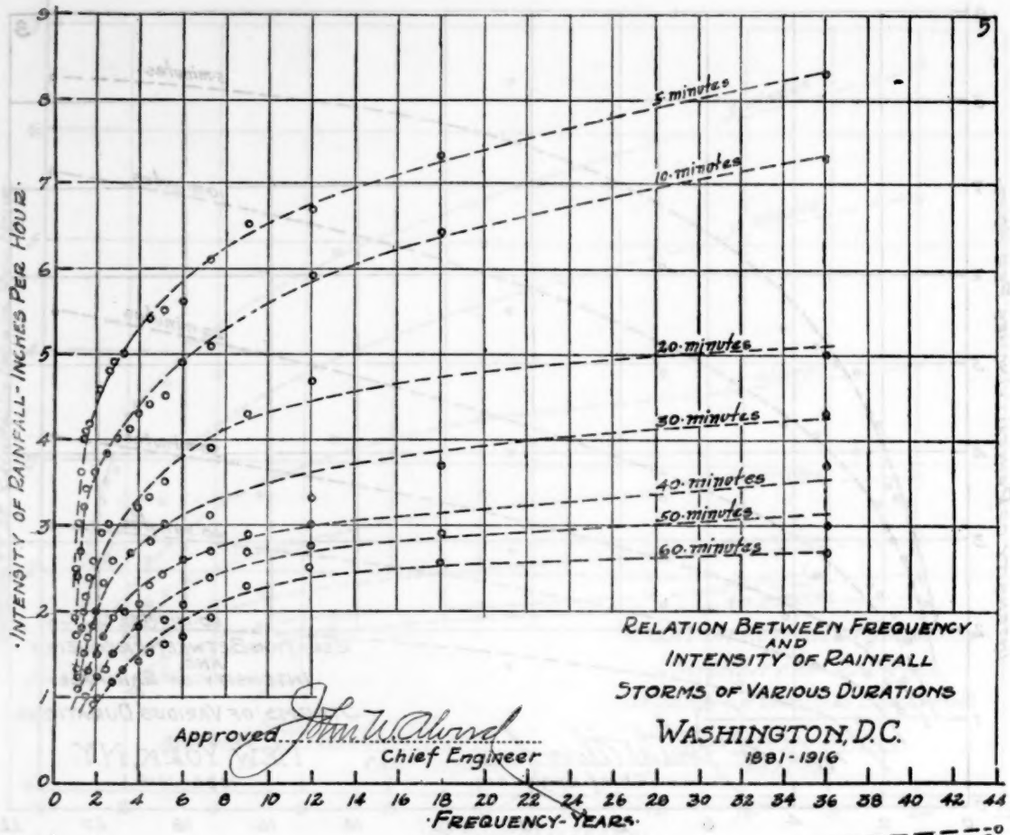
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL
STORMS OF VARIOUS DURATIONS
NEW YORK, N.Y.
1896 - 1916
Approved
Chief Engineer


A
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL
STORMS OF VARIOUS DURATIONS
PHILADELPHIA, PA.
1896 - 1916
Approved
Chief Engineer


5
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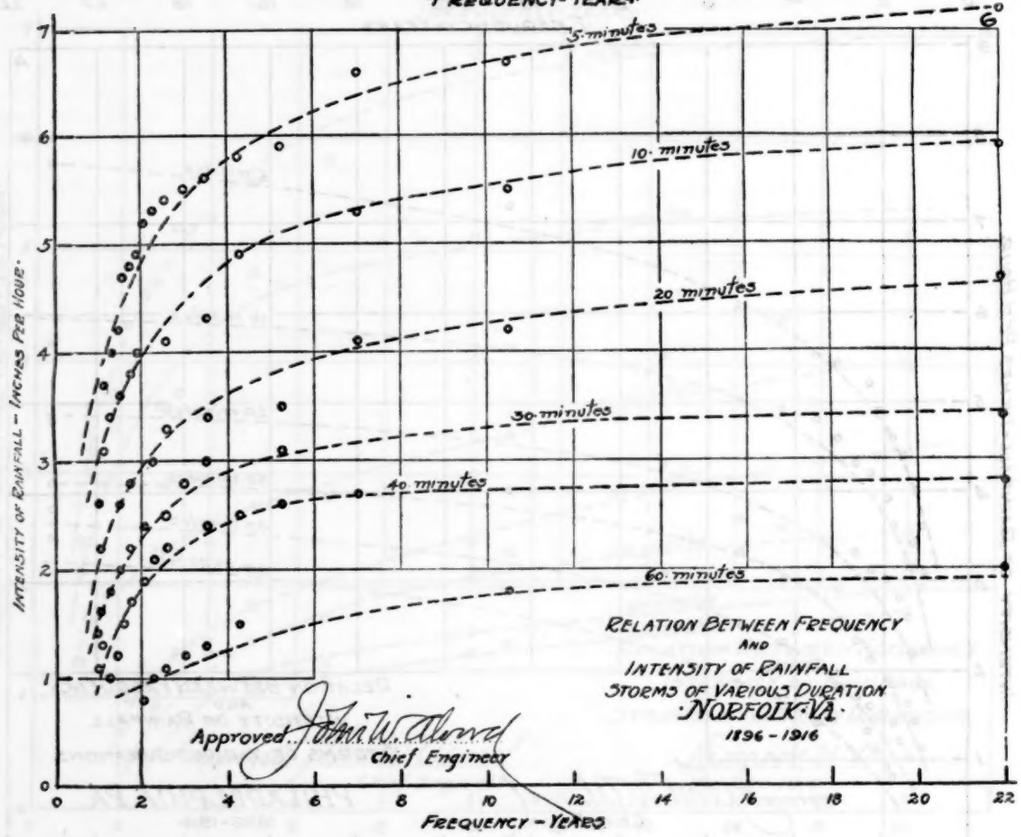
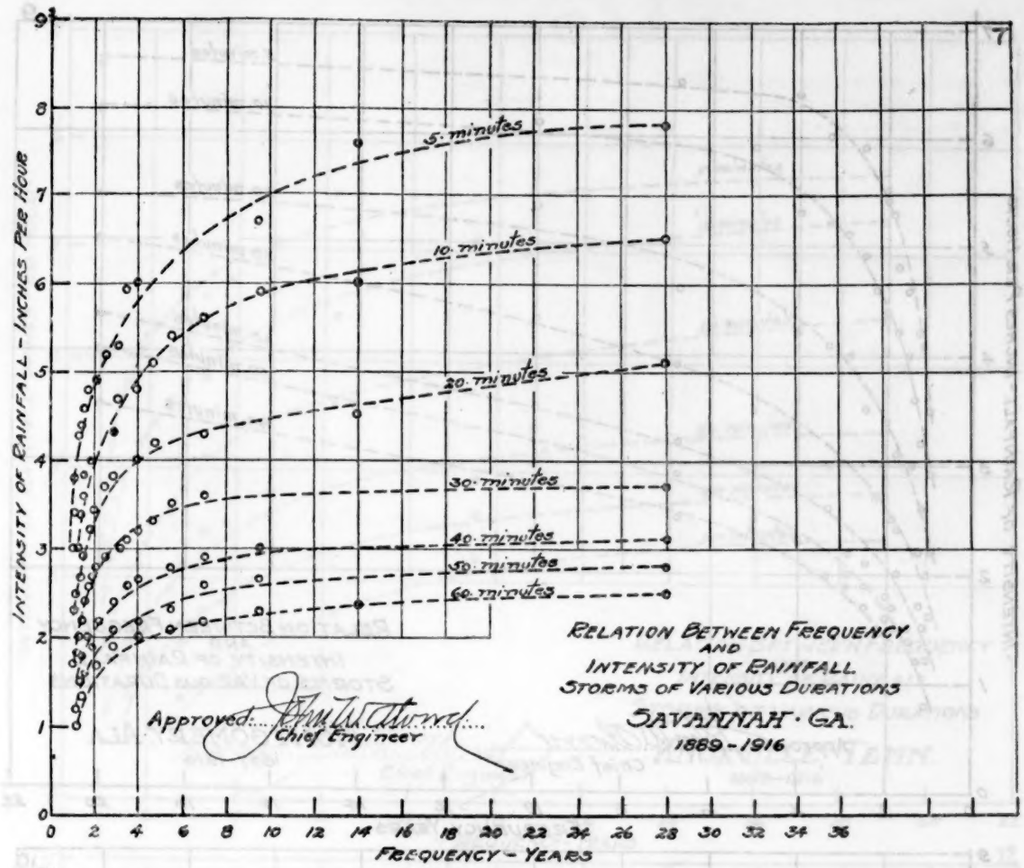
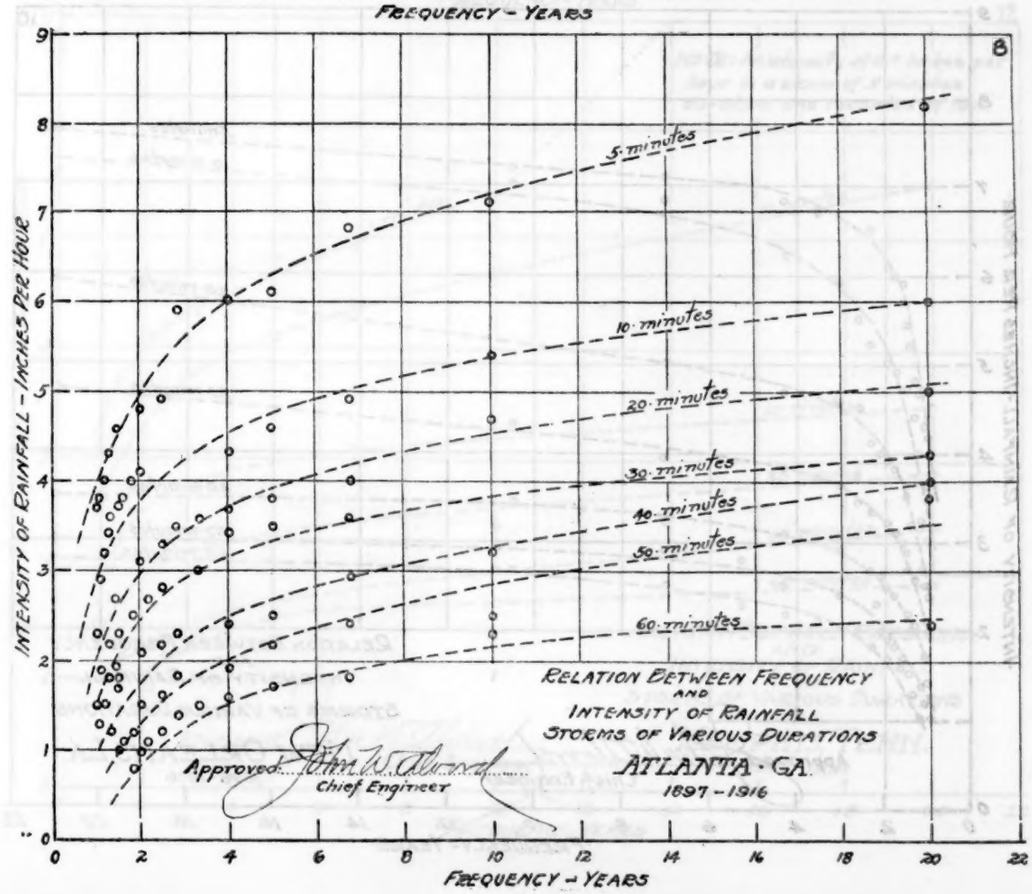
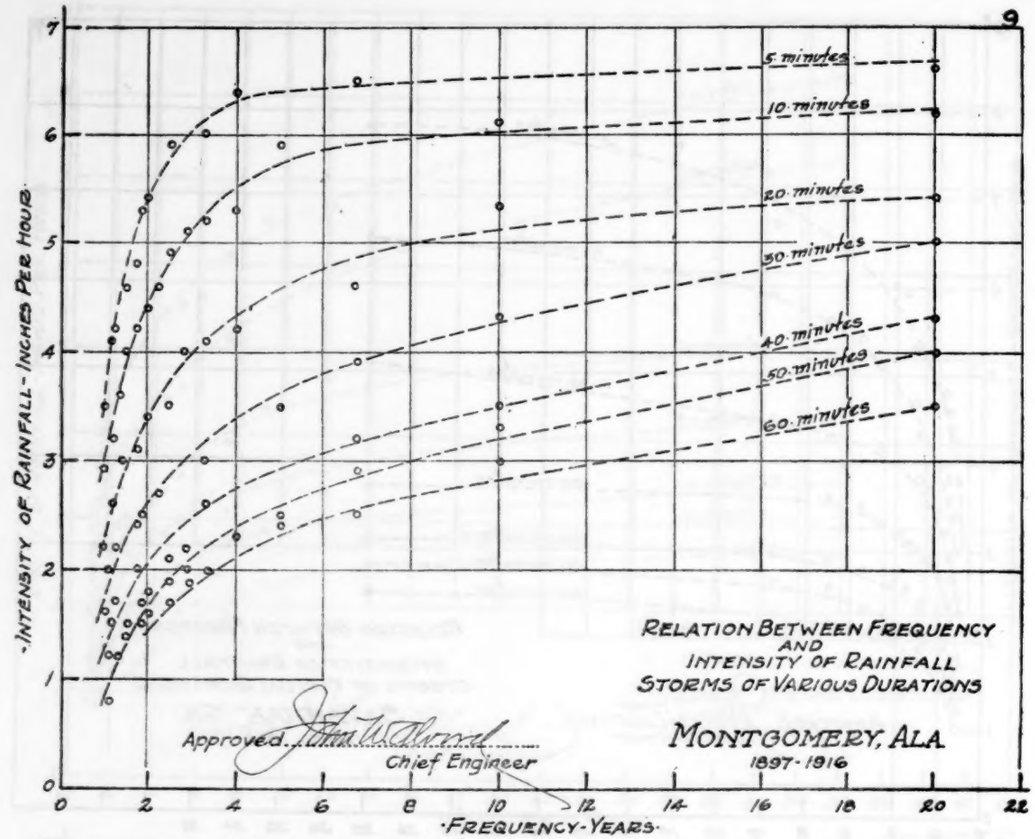
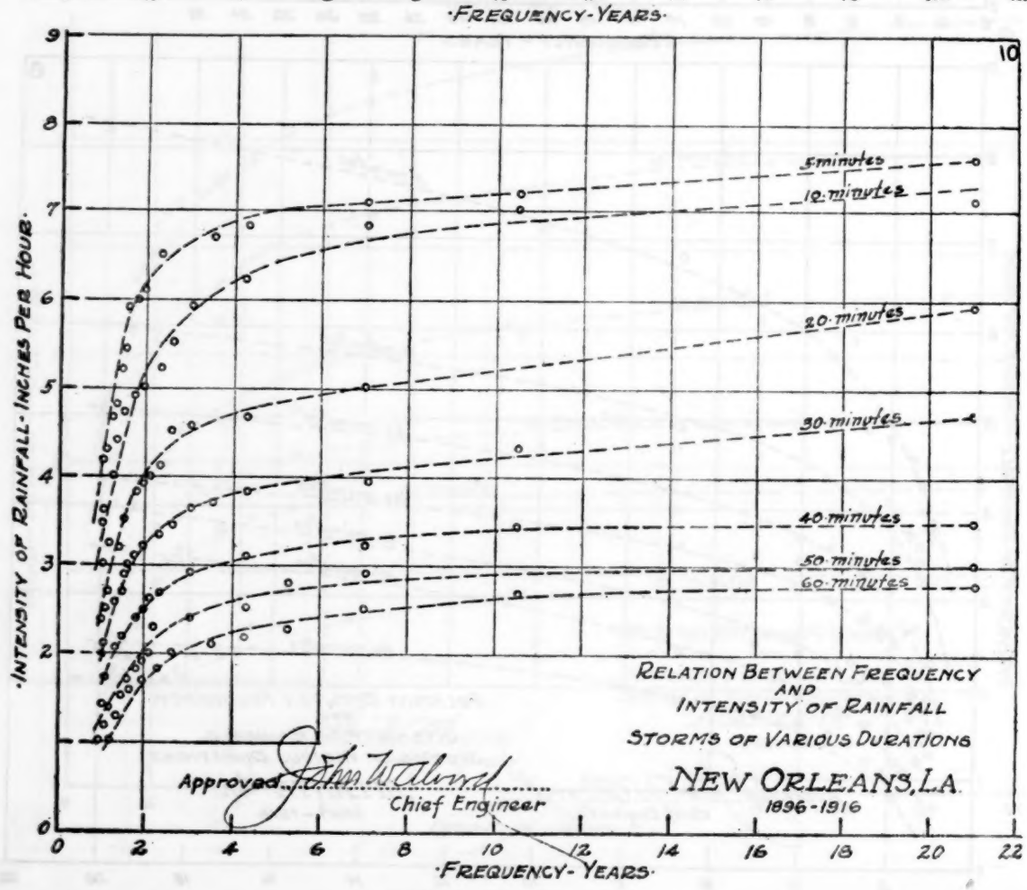
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR.
FREQUENCY - YEARS.
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
WASHINGTON, D.C.
1881 - 1916
Approved John W. Alvord
Chief Engineer

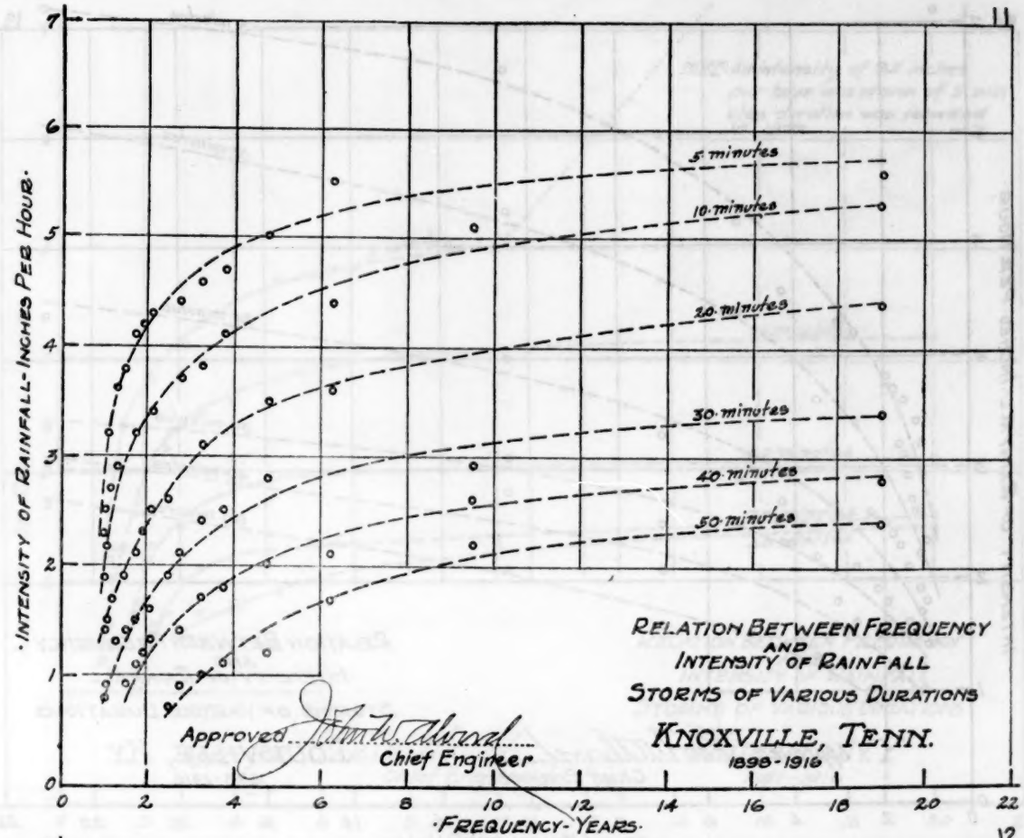

6
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR.
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATION
NORFOLK, VA.
1896 - 1916
Approved John W. Alvord
Chief Engineer

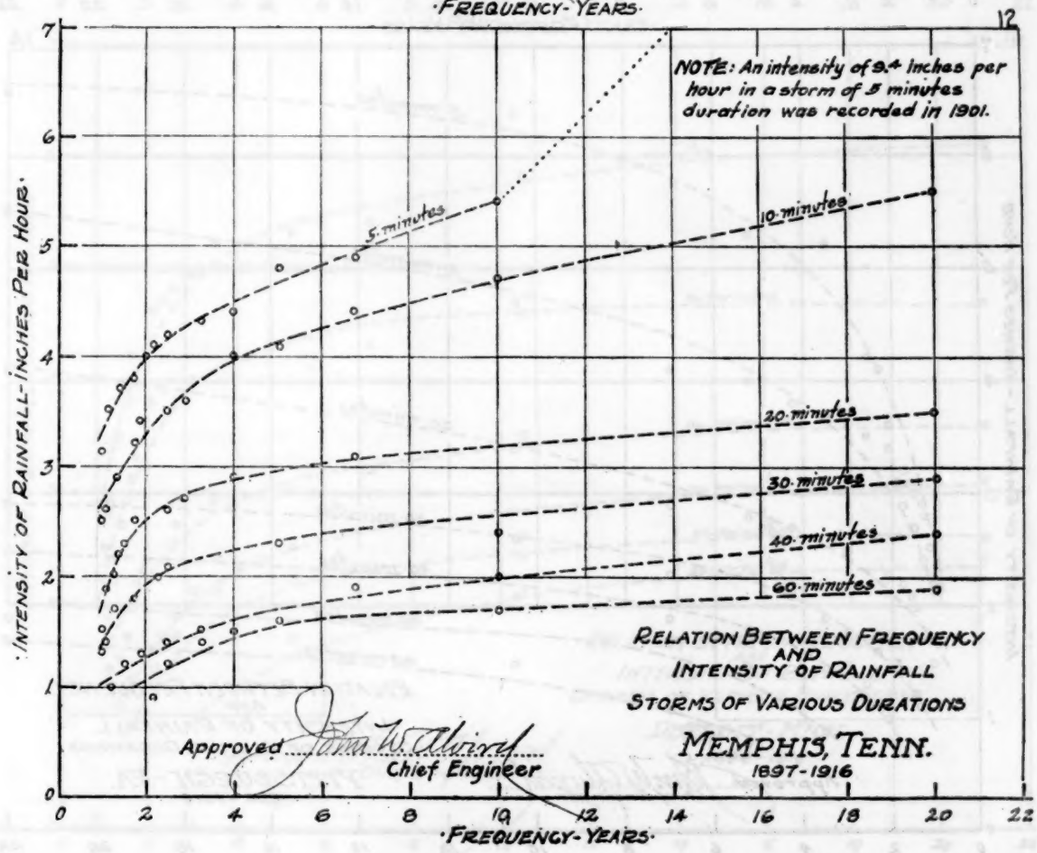

7
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
SAVANNAH · GA.
1889 - 1916
Approved: John W. Alvord
Chief Engineer

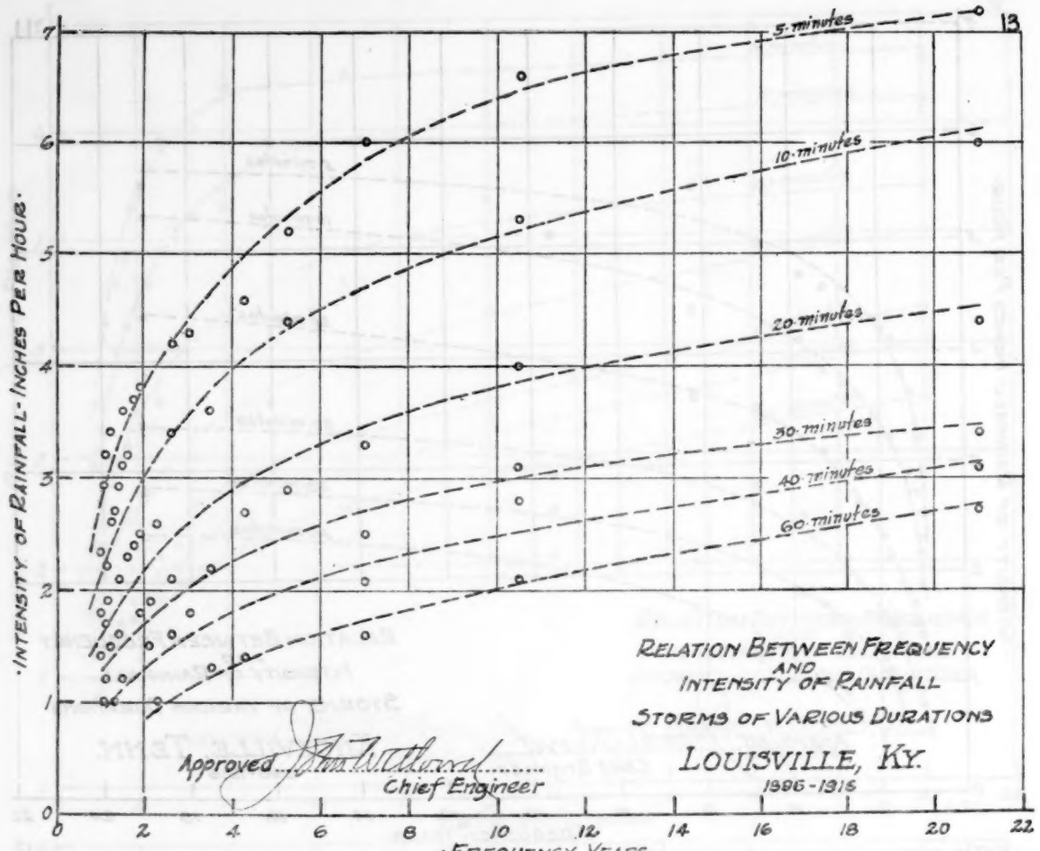

8
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
ATLANTA · GA.
1897 - 1916
Approved: John W. Alvord
Chief Engineer

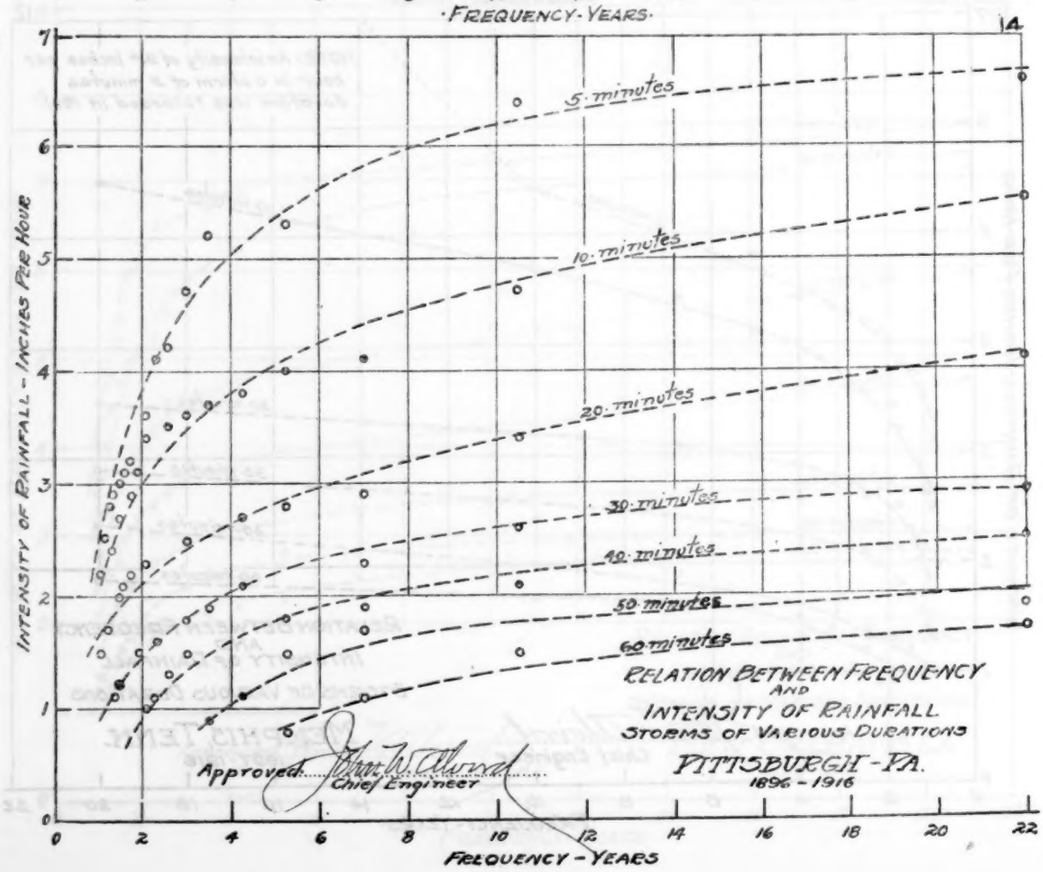

9
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
Approved. John W Alvord
Chief Engineer
MONTGOMERY, ALA
1897-1916

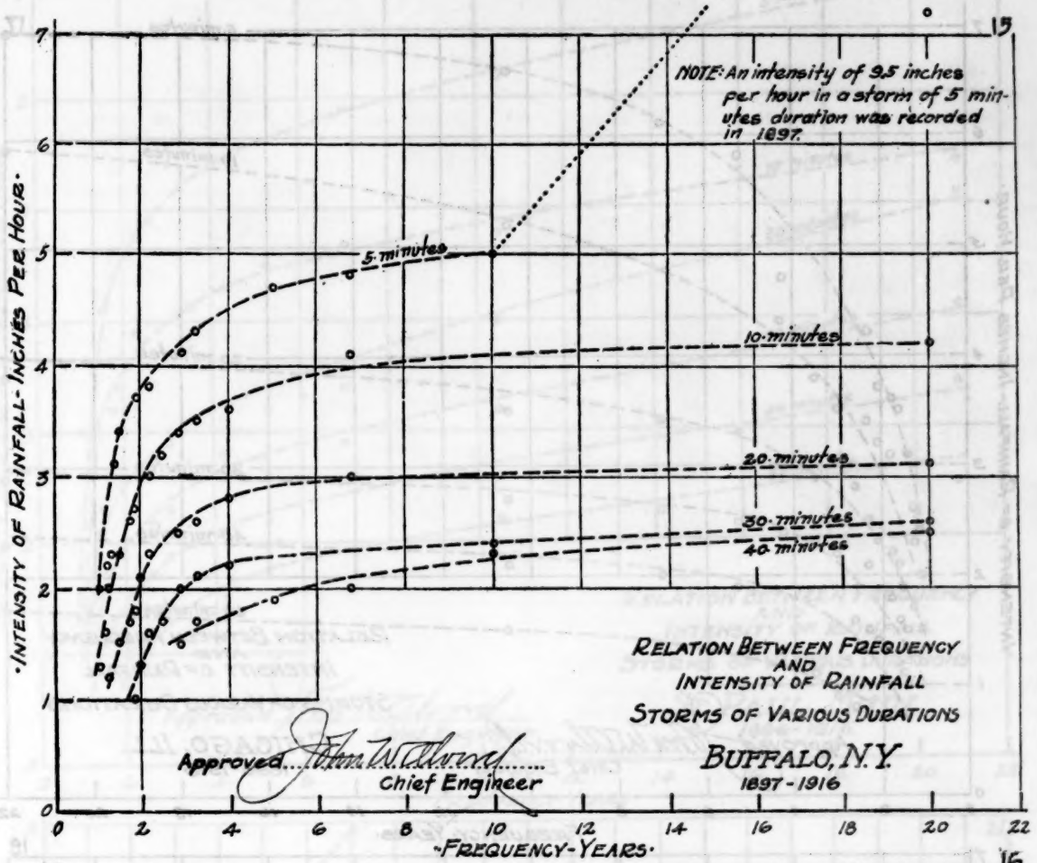

10
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
Approved. John W Alvord
Chief Engineer
NEW ORLEANS, LA.
1896-1916

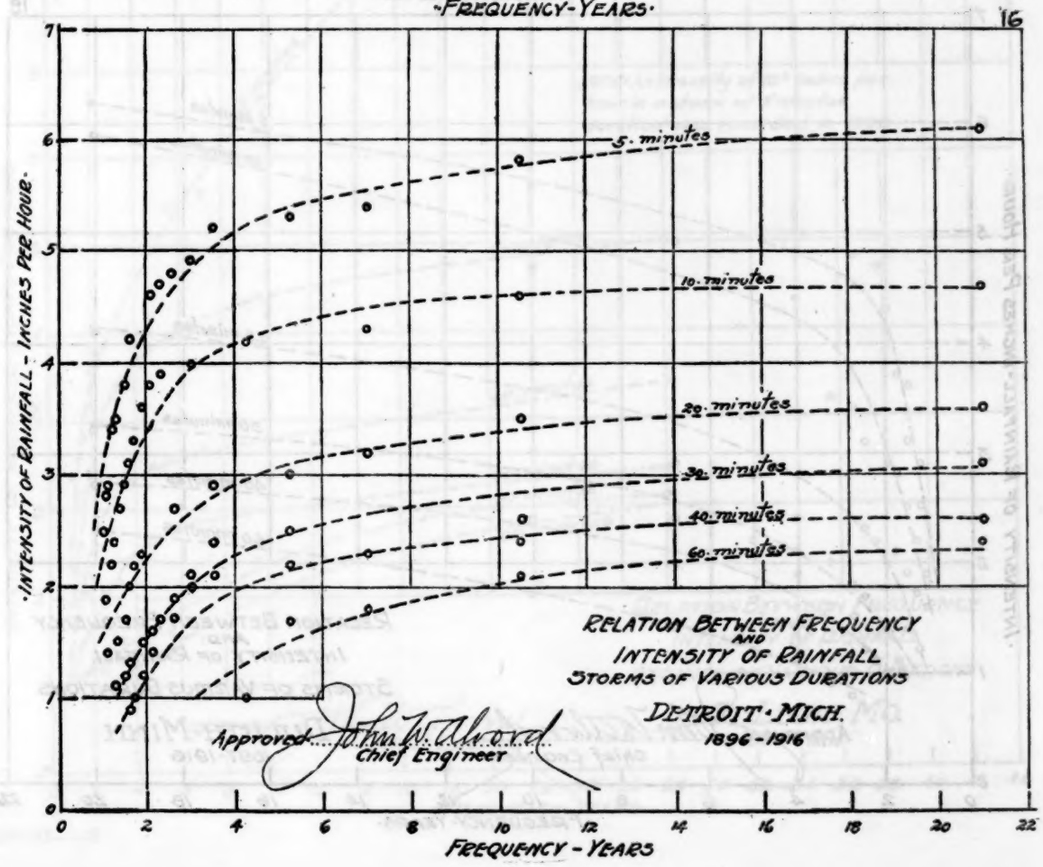

11
INTENSITY OF RAINFALL-INCHES PER HOUR
FREQUENCY-YEARS
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
KNOXVILLE, TENN.
1898-1916
Approved John W. Alvord
Chief Engineer

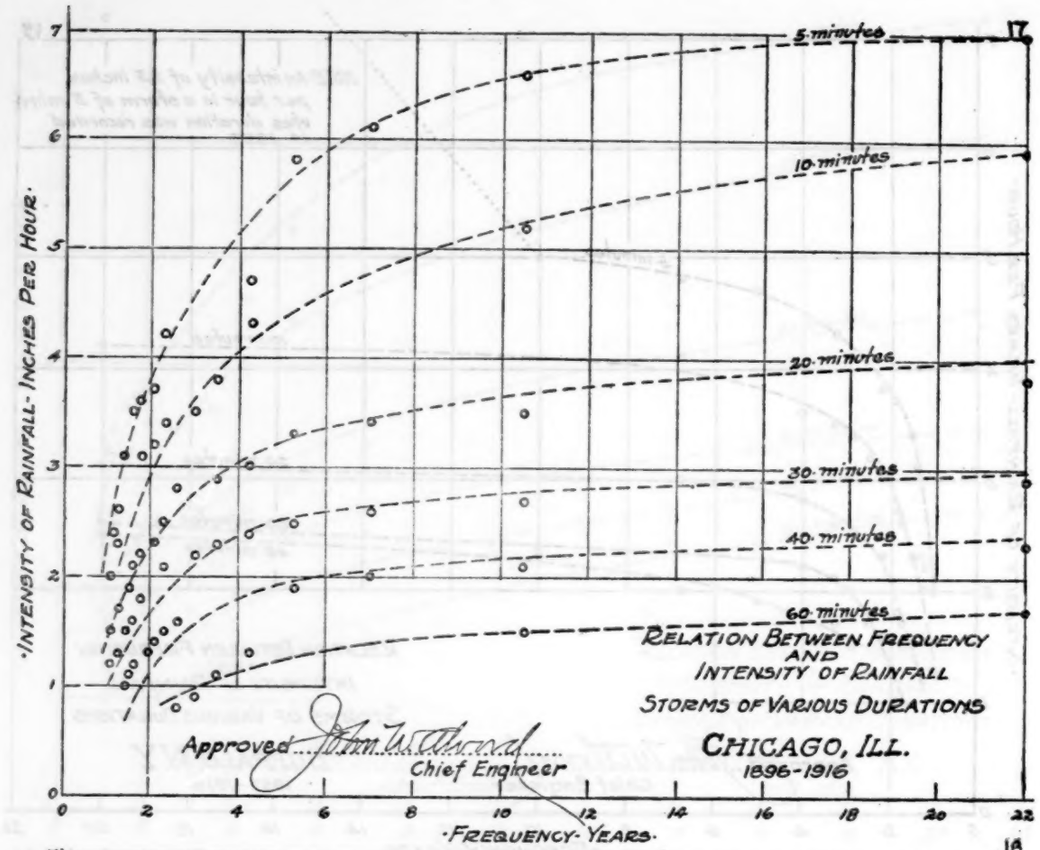

12
NOTE: An intensity of 9.4 inches per hour in a storm of 5 minutes duration was recorded in 1901.
INTENSITY OF RAINFALL-INCHES PER HOUR
FREQUENCY-YEARS
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
60 minutes
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
MEMPHIS, TENN.
1897-1916
Approved John W. Alvord
Chief Engineer

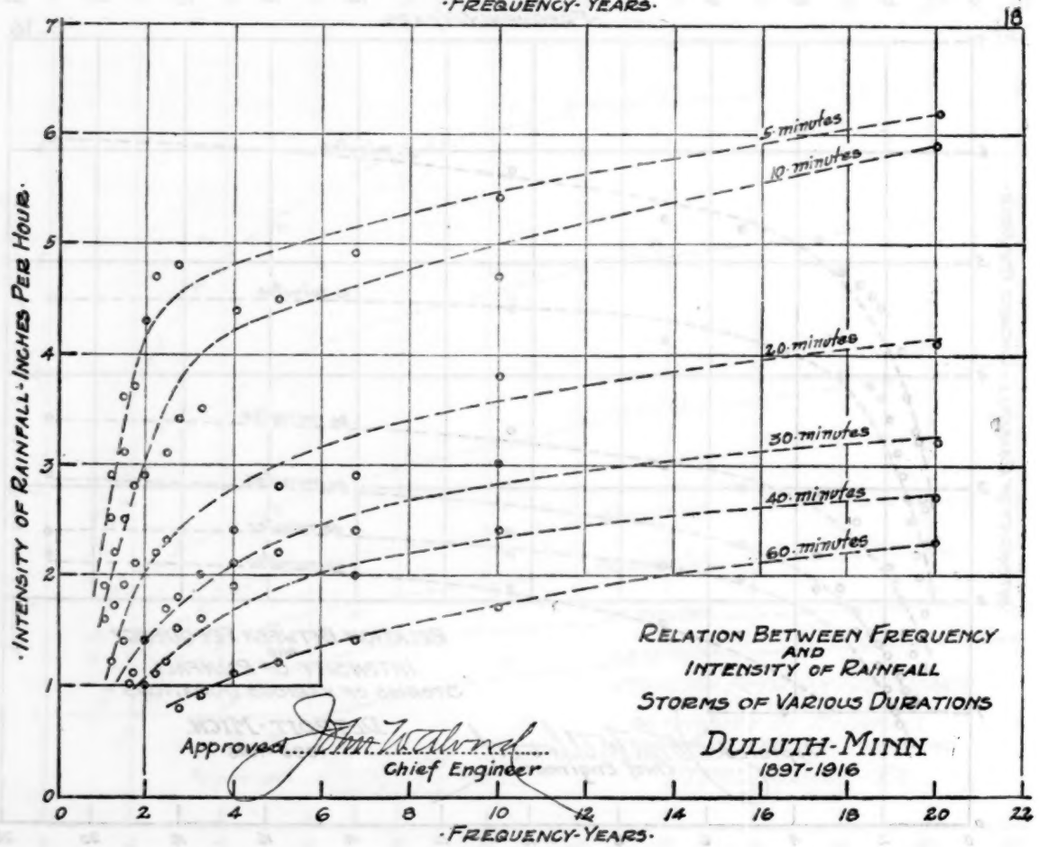

13
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
LOUISVILLE, KY.
1896 - 1915
Approved
Chief Engineer

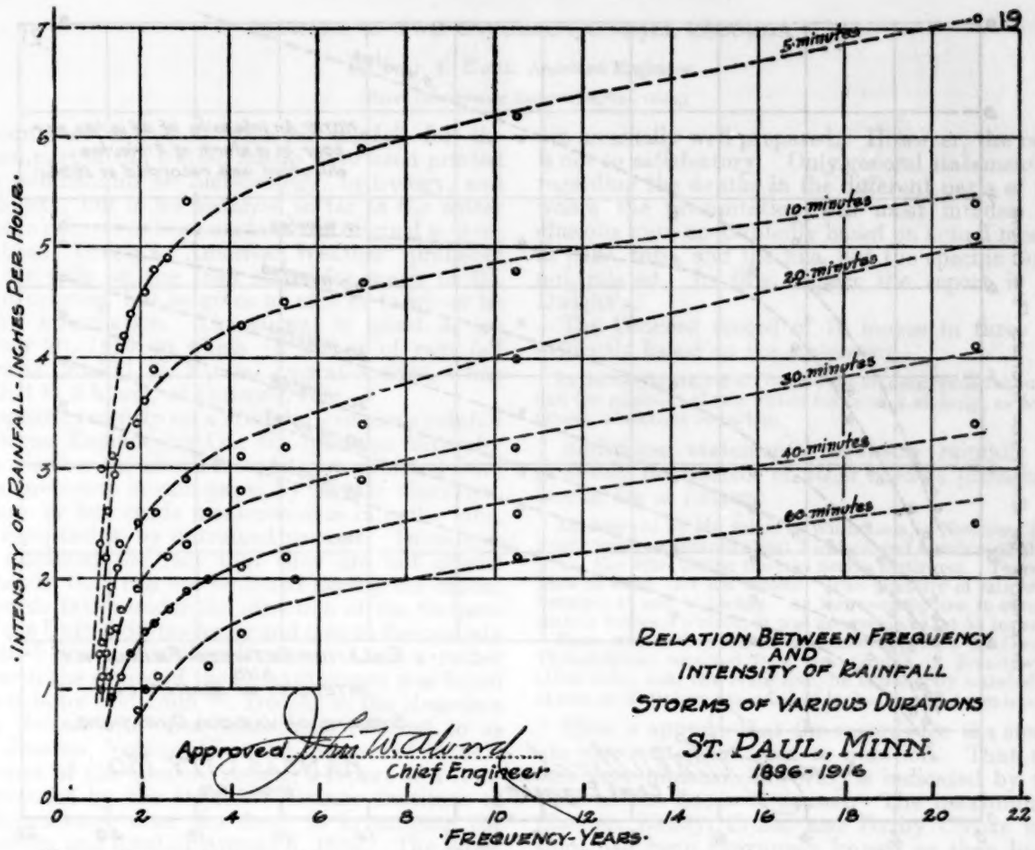

14
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
50 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
PITTSBURGH - PA.
1896 - 1916
Approved
Chief Engineer

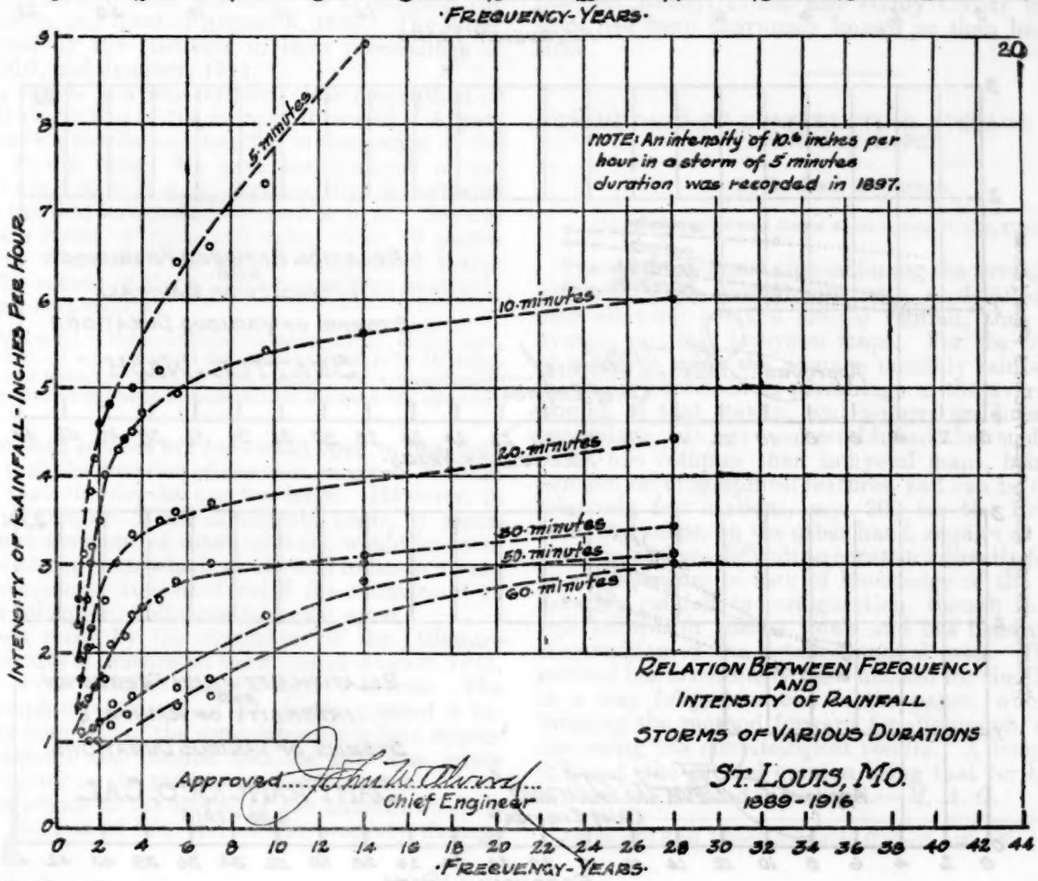

15
NOTE: An intensity of 3.5 inches per hour in a storm of 5 minutes duration was recorded in 1897.
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
BUFFALO, N.Y.
1897 - 1916
Approved John W. Alvord
Chief Engineer

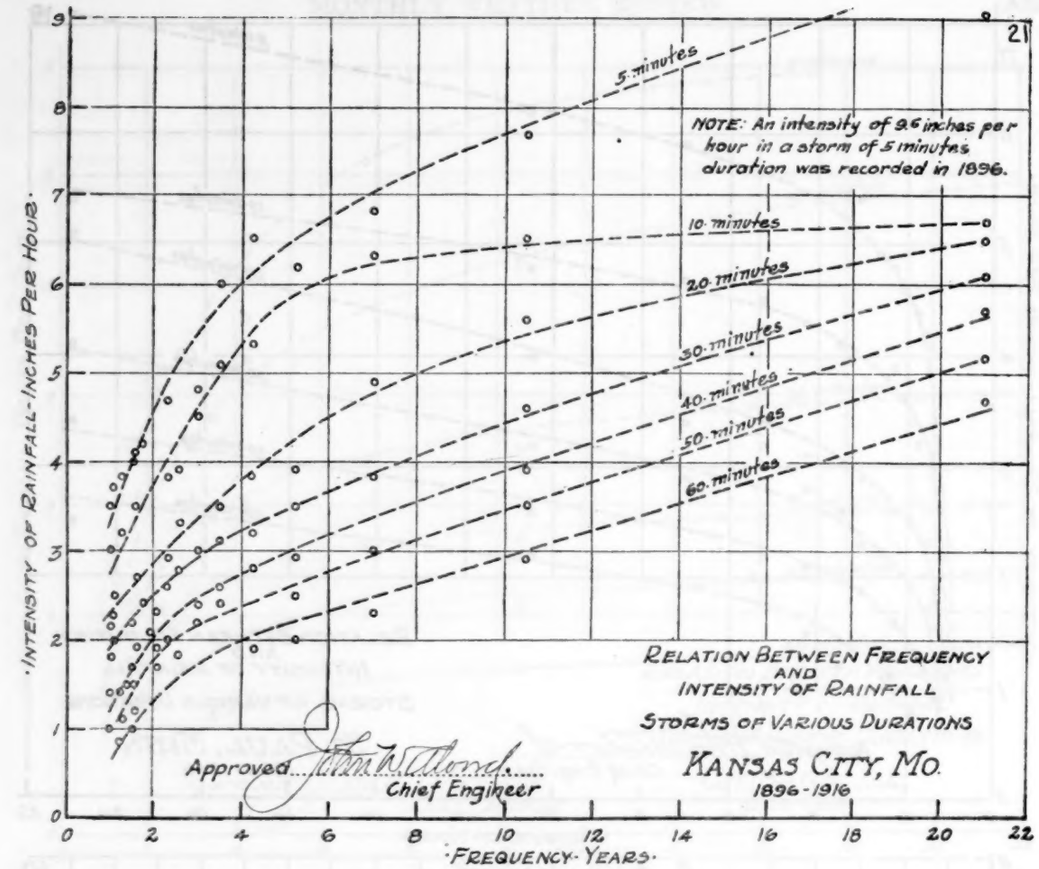

16
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
DETROIT, MICH.
1896 - 1916
Approved John W. Alvord
Chief Engineer


17
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR.
FREQUENCY - YEARS.
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
CHICAGO, ILL.
1896-1916
Approved ... John W. Alvord ... Chief Engineer


18
5 minutes
10 minutes
20 minutes
30 minutes
40 minutes
60 minutes
INTENSITY OF RAINFALL - INCHES PER HOUR.
FREQUENCY - YEARS.
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
DULUTH-MINN
1897-1916
Approved ... John W. Alvord ... Chief Engineer


19
5-minutes
10-minutes
20-minutes
30-minutes
40-minutes
60-minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL
STORMS OF VARIOUS DURATIONS
ST. PAUL, MINN.
1896 - 1916
Approved
Chief Engineer


20
NOTE: An intensity of 10.6 inches per hour in a storm of 5 minutes duration was recorded in 1897.
5-minutes
10-minutes
20-minutes
30-minutes
40-minutes
60-minutes
INTENSITY OF RAINFALL - INCHES PER HOUR
FREQUENCY - YEARS
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL
STORMS OF VARIOUS DURATIONS
ST. LOUIS, MO.
1889 - 1916
Approved
Chief Engineer


21
5 minutes
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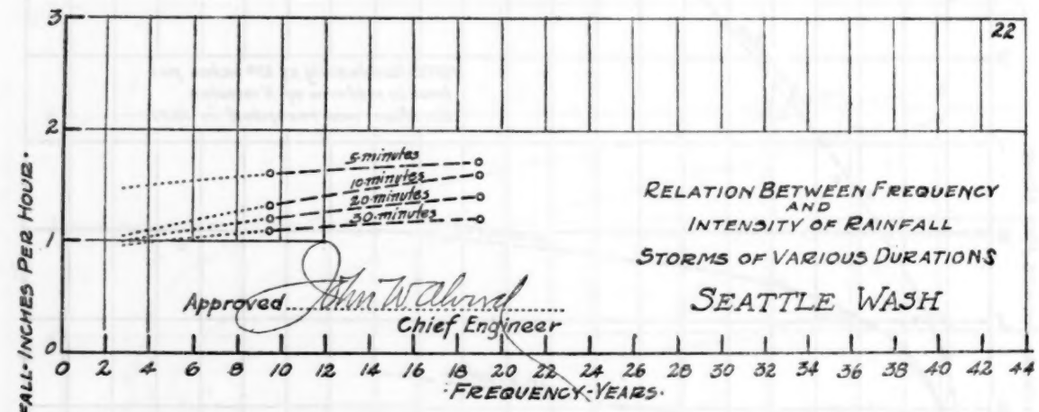
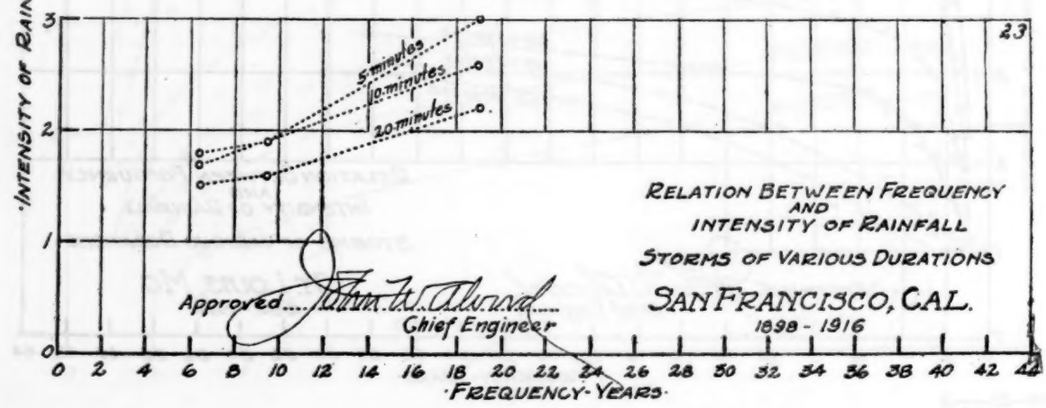
60 minutes
NOTE: An intensity of 9.6 inches per hour in a storm of 5 minutes duration was recorded in 1896.
INTENSITY OF RAINFALL-INCHES PER HOUR.
FREQUENCY-YEARS.
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
KANSAS CITY, MO.
1896-1916
Approved John W. Alvord Chief Engineer


22
5 minutes
10 minutes
20 minutes
30 minutes
INTENSITY OF RAINFALL-INCHES PER HOUR.
FREQUENCY-YEARS.
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
SEATTLE WASH
Approved John W. Alvord Chief Engineer


23
5 minutes
10 minutes
20 minutes
INTENSITY OF RAINFALL-INCHES PER HOUR.
FREQUENCY-YEARS.
RELATION BETWEEN FREQUENCY AND INTENSITY OF RAINFALL STORMS OF VARIOUS DURATIONS
SAN FRANCISCO, CAL.
1898-1916
Approved John W. Alvord Chief Engineer

SOURCES OF TWO UNUSUAL RAINFALL RECORDS.

By IVAN E. HOUK, Assistant Engineer.

[Miami Conservancy District, Dayton, Ohio.]

Two records of extremely unusual rainfall for the northeastern part of the United States have been printed in various publications on meteorology, hydrology, and related subjects; but in no instance, so far as the writer can find, have references been made to the original sources of information. Greely's "American Weather" probably furnished the data on the 1843 storm for many of the more recent articles; but he gives no clue as to where he obtained his information. The storms in question are those of July 26, 1819, in which 18 inches of rain fell in 7½ hours at Catskill, N. Y., and August 5, 1843, when 16 inches fell in 3 hours, at Concord, Pa.

Being engaged recently on a study of excessive rainfall for the Morgan Engineering Co., the question naturally arose as to whether the above records were obtained from actual measurements in rain-gages, by regular observers, or from more or less crude measurements in pails, tubs, or similar receptacles, by untrained persons. Investigation soon disclosed the fact that they are not official records; that is, they can not be found among the official rainfall records taken under the direction of the Surgeon General of the United States Army and now in the custody of the United States Weather Bureau. After a rather lengthy search the source of the Catskill record was found to be an article by Benjamin W. Dwight in the *American Journal of Science and Arts*, sometimes referred to as *Silliman's Journal*, Volume IV, 1822, pages 124 to 142; and the source of the Concord record, a report of a committee appointed by the Delaware County Institute of Science, immediately after the flood, to investigate the great rainstorm and flood of August 5, 1843. The latter was reprinted by the Institute in their proceedings of October, 1910, and January, 1911.

Dwight's article is a well-written, clear description of the Catskill storm and of the damage it caused. Apparently he made a careful and lengthy investigation of the conditions at the time. He gave the duration of the rainfall as from 3.30 to 11 p. m., but said that the extreme violence of the rain terminated before 6.30 p. m. Several instances are noted of pails and tubs, 15 or 16 inches deep, empty when the rain began, being filled before sunset. The source of the 18-inch record was evidently the following statements:

> About 6 miles south of the courthouse an empty barrel, in the open, caught 18 inches. I am persuaded that the water fell fully 15 inches on the level over a tract of about 80 square miles. On a considerable part of the tract there is reason to believe that the quantity exceeded 18 inches.

Of course such records are somewhat open to question. It is likely that the duration of the rain, as given, is about right, but that the depths are too large. However, in view of the number of measurements made, it seems probable that some one of them, at least, would be accurate within 25 per cent, which would still indicate a very unusual downpour. It is doubtful if the estimate of 15 inches over 80 square miles can be relied upon.

The report made by the committee of the Delaware County Institute of Science on the storm of August, 1843, was much more detailed than Dwight's article. The original pamphlet consisted of 52 closely printed 8 vo. pages. The members of the committee made field inspections throughout the flooded sections and also wrote letters of inquiry to the more prominent citizens.

The descriptions of the storm, of the unusual floods it caused, of the loss of life, and of the property damage are unusually well prepared. However, the rainfall data is not so satisfactory. Only general statements are made regarding the depths in the different parts of the county where the precipitation was most intense. The conclusions were undoubtedly based on actual measurements in pails, tubs, and the like, but the specific instances are not related. In this respect the report is inferior to Dwight's.

The Concord record of 16 inches in three hours was evidently based on the statement—

> In the neighborhood of Concord the rain continued about three hours, and the quantity of rain which fell in that vicinity, as nearly as ascertained, was about 16 inches.

Additional statements regarding rainfall, which are probably the sources of other records published for this storm, are as follows:

> As observed by Mr. Adam B. Williamson, of Newtown Township, the heavy rain commenced about 2 o'clock and terminated about 5 o'clock p. m., the wind during the rain nearly northwest. There was a heavy blow of wind, but not violent. The quantity of rain which fell was between 11 and 13 inches. At Newtown Square, in 40 minutes immediately before 5 o'clock, it was ascertained that 5½ inches of rain fell.
>
> From well authenticated information, which he (Prof. Frazer, of Philadelphia) received from Mrs. Grubb, in Brandywine Hundred (Delaware), near the State line, he is perfectly satisfied that the fall of rain at that place exceeded 10 inches in about two hours.

Thus it appears that the records for the storm of 1843 are also somewhat open to question. That the rainfall was very unusual, however, is indicated by the magnitude of the floods it caused. The maximum stages in Chester, Ridley, Crum, and Darby Creeks were higher than had been previously known or than has occurred since.

NEW METHOD OF CONSTRUCTING AVERAGE MONTHLY RAINFALL MAPS.[1]

By M. DEC. S. SALTER.

[Abstract reprinted from *Science Abstracts*, Aug. 31, 1921, §1389, p. 550.]

The method consists in combining the average monthly isomeric maps individually with a detailed isohyetal map showing average annual rainfall, thus producing average monthly isohyetal maps. For the construction of isomeric maps the average monthly rainfall for each station is expressed as percentage of the average annual rainfall of that station, and isomers are lines of equal percentage. It has been established that such maps are much less complex than isohyetal maps, being less dependent on orographical features, and can be drawn with relatively few stations, say, 200 for the British Isles. Isohyetal maps, on the other hand, require at least 2,000 stations, and are difficult to construct directly for monthly averages, owing to lack of knowledge of the relation of monthly rainfall to configuration, though this is fairly well known for annual totals and has been used in the construction of the detailed annual map. The indirect method has accordingly been utilized for the British Isles in a way fully described in the paper, which aims at bringing the method forward for discussion, and not at discussing the climatological results. A long discussion followed, the general opinion being that for the purpose in view the method is justified.—*M. A. G.*

[1] *Journal of the Royal Meteorological Society*, 47:101–116, April, 1921.

DISTRIBUTION OF PRECIPITATION IN NORTH GERMANY.[1]

By GUSTAV HELLMANN.

[Reprinted from *Science Abstracts*, 1921, 24: 215.]

The region considered is, roughly, that part of Germany lying north of latitude 50° N. Charts and data showing monthly and yearly averages based on 20 years' observations are published elsewhere, and the general results are discussed in this paper. Two tables are at present devoted to yearly averages, the one giving this information for individual provinces and the other showing the percentage area of each province which receives an annual rainfall between given limits. Posen is the driest (509 mm.), 42.4 per cent of the area receiving less than 500 mm., 57.1 per cent between 500 mm. and 600 mm., and 0.5 per cent between 600 mm. and 700 mm. The wettest is Westphalia (807 mm.), 50.4 per cent receiving between 700 mm. and 800 mm., while, quoting extremes, 1.1 per cent receives between 500 mm. and 600 mm., and 1.1 per cent between 1200 mm. and 1400 mm.

Monthly averages are expressed as percentages of the yearly sum, and three types of yearly distribution are recognized, according to the position of the maxima; (1) a single maximum in a particular month, (2) one or more secondary maxima, (3) a transition type in which a month adjacent to a maximum is almost as high itself. A map shows the distribution of these types, the salient features being that type (1) with a July maximum is by far the most extensive and that there is a general transition from a June maximum in the south to an October maximum in the north, September being passed over without showing as a maximum in any district. The driest month is March in East Prussia, February in the central regions and April in the west. The distribution of the amplitude, expressed as a percentage of the yearly sum, is illustrated by a map which shows a decrease from 12.5 per cent in the east to 3.5 per cent in the west, with a tendency for areas of maximum on the lee side of mountains. There is a rapid decrease with altitude in mountain districts.—*M. A. G.*

EARLY RECORDS OF TROPICAL HURRICANES ON THE TEXAS COAST IN THE VICINITY OF GALVESTON.[2]

By REX D. FRAZIER.

[Houston, Tex., March 21, 1916.]

NOTE.—The following account of the hurricanes which visited the Texas coast in the vicinity of Galveston in early times is excerpted from a report rendered by Mr. Frazier to the Galveston-Houston Electric Railway Co. The record is here carried up to 1876, which is the date at which Dr. Oliver L. Fassig's record (Weather Bureau Bulletin X, "Hurricanes of the West Indies") begins. While Mr. Frazier has only considered storms affecting Galveston and vicinity, Dr. Fassig has treated the subject with respect to the frequency, the tracks of the storms, and their annual distribution; hence the records are not comparable. However, aside from its historical interest, this record of early storms may have uses of a scientific character. Mr. Frazier's courtesy in submitting his entire report to the Weather Bureau is acknowledged.—EDITOR.

Tradition tells of great gales that have swept the Texas coast, inundating it to a great extent and uprooting trees, casting ships far inland, and changing coast lines. Historical reference is made to gales that wrecked the ships of the early explorers. Probably the first is in the narrative of Alver Nunez, a Spanish explorer, who, with 48 companions, the survivors of a party of 240, was cast ashore during a gale in November, 1527. They landed on an island called Malhado, which, according to historians, was in all probability Galveston Island. La Salle in his wanderings along the Texas coast searching for the mouth of the Mississippi river encountered severe gales.

According to the Spanish chroniclers, a severe gale on September 4, 1766, destroyed a mission on the shore of Galveston Bay and caused a high tide which inundated the land.

Several years ago the writer was told that the bleaching hulk of a wrecked vessel stood 40 miles inland on the prairie between Matagorda and Copano Bays. This vessel had been there within the memory of the earliest settlers. About eight or nine years ago the rotting hulk of an old vessel was uncovered at a point about 25 miles west of Houston. This find was at least 40 miles from the nearest salt water, but as it was only 4 miles from the channel of the Brazos River very likely it had been carried overland and buried during one of the periodical floods of that stream. The oldest resident in that vicinity did not know when the vessel had been wrecked, so it evidently occurred in the early part of the past century or possibly earlier.

From the best authorities it is learned that up to the year 1816 Galveston Island was uninhabited, and it is probable that the only human beings regularly visiting the island were the Carankawa (also spelled "Carancahau") Indians. This was a tribe of stalwart savages, having the reputation of being cannibals, who hunted along the Texas coast and crossed to Galveston by a series of shoals about 15 miles west of the city. This string of shoals or reefs still bears their name.

In the narrative of Col. Warren D. C. Hall, printed in 1859, Galveston Island in 1816 is mentioned as Snake Island, or Isle de Calebras, as it was called by the Mexicans and Indians, and was not generally known, if at all, as Galveston. However, all the islands along the Texas coast were called Isles de Calebras in consequence of the number of rattlesnakes to be found in the driftwood and sand hills common to all of the islands next to the Gulf shore. According to Col. Hall, the island in 1816 was composed mainly of marsh, with an occasional ridge or elevation of 2 or 3 feet, and the whole surface, with the exception of the bays and bayous, was covered with a luxuriant growth of grass.

The main island was separated from a smaller one to the eastward by a pass from the Gulf 5 or 6 feet deep, and the eastern island was known as Little Campeachy. Col. Hall fails to mention that Galveston Island was called Campeachy, which is mentioned by different historians. According to an issue of the *Galveston News* under date of Tuesday, June 4, 1869, Don Luis Aury visited Galveston Island on May 10, 1817, and found the pirate Lafitte, driven from Barataria, in full possession of the island. Aury mentions that the island was called Campeachy.

At that time Pelican Island was merely a narrow piece of marsh on which it was impossible to walk dry-footed, except upon a small spot about 100 feet in length. The marsh, covered with sea grass growing in the mud, was covered with water at high tide and was not visible at any distance. Col. Hall mentions that by 1820 the island had increased to a kind of shell bank, the east side of

[1] *Preuss. Akad. Wiss.*, Berlin, 1919, 38: 980–990.
[2] Cf. also Early Texas coast storms. MO. WEATHER REV., Sept., 1919, 47: 641–642.

which had a few small bushes growing upon it. As this was after the hurricane of 1818, it is evident that this storm or some previous hurricane changed the contour and topography of the island. The writer has examined old charts of portions of the Texas coast he is familiar with. All were much different than at present. Islands and channels have appeared and disappeared during the past century; bays have changed their depths and bottom; and the general shape of the shore has greatly changed. Without a doubt hurricanes have been the cause. In a previous report mention is made of the loss of several blocks of land off the east end of the city of Galveston during a hurricane. In the 1900 hurricane Galveston lost from one-half to two blocks of land fronting the entire Gulf shore. In the August, 1915, hurricane, the beach outside of the sea-wall disappeared, and on Bolivar peninsula the waters of the Gulf encroached to such an extent that the Gulf & Interstate Railway Co. was compelled to secure 20 miles of new right of way. The waters of the Gulf now cover the site where their tracks were located immediately before the hurricane.

Col. Hall also saw in 1820 what are now known as Deer Islands, west of the location of the causeway. Now they are of fair size, but he described them as not having an acre of dry land on the largest, and further mentioned that they were entirely covered with water during high tides. They were then known as Egg Islands, and there was not a bush or shrub on them.

Crossing Galveston Island to the sand hills in the western portion of the present city limits there was an almost continuous marsh, a large portion of which was subject to overflow at periods of high tide.

The first great gale that visited Galveston of which there is any authentic record was in 1818, when four of Lafitte's vessels were sunk or driven ashore. Without doubt this was a hurricane whose center passed over or near the island. In the following year Col. Hall mentions that he saw the wrecks of these vessels. One was lying near L'Allemande's fort, the highest point of the island, and another was ashore at Virginia Point, the apex of the adjacent mainland to the north.

Owing to the fact that there was no settlement on Galveston Island and only at intervals was it visited by hunting and camping parties, the next mention of a hurricane is in the year 1837. On October 6 several buildings in the course of construction were blown down and a number of vessels sunk or driven ashore, among them being the man of war *Brutus* and the privateer schooner *Tom Toby*.

The following account of this hurricane is from the *Telegraph and Texas Register* (the first paper printed in Houston), October 11, 1837:

> The late accounts from the seaboard are of the most distressing character. A tremendous gale appears to have swept the whole line of the coast and destroyed an immense amount of property. It commenced on the 1st and increased in violence until the 6th. At Velasco four houses were blown down; the whole country for miles around inundated and all of the vessels in the harbor, consisting of the brig *Sam Houston*, and the schooners *De Kalb*, *Fannin*, *Texas*, and *Caldwell*, were driven ashore. The last named has since been got off and cleared on Sunday last for New Orleans. At Galveston the waters were driven in with such violence that they rose 6 or 7 feet higher than the ordinary spring tide. They inundated a large portion of the east end of the island and compelled soldiers of the garrison to desert their barracks and seek shelter on the elevated ground near the intended site of Galveston City.
>
> The large new warehouse of Mr. McKinney and the new customhouse were completely destroyed and the goods scattered over the island. The brigs *Perseverance*, *Jane*, and *Elbe* (the latter a German vessel) were driven ashore and are complete wrecks; the *Phœnix* is also ashore, but slightly injured, and may be easily set afloat again. The schooners *Select*, *Henry*, *Star*, *Lady of the Lake*, and the prize schooner *Correo* are ashore, some of them high and dry. The *Tom Boy* (privateer) is a wreck, and the *Brutus* (Texan naval schooner) is considerably damaged. The schooner *Helen* is the only vessel which has received no damage. So far as we have been able to learn only two individuals have perished. The history of this country contains no record of any hurricane that has equaled this, either in the violence of the storm or the extent of the destruction. There is a reason to believe that the destructive influence of this gale has extended gradually over the surface of the Gulf; we therefore apprehend that the next intelligence from the United States and from Mexico will be rife with accounts of disastrous shipwrecks. We sincerely trust that neither the calamities of enemy nor friend will equal our own.

The *Galveston News*, under date of June 4, 1839, states that the newly completed Tremont Hotel, built on the site of the present building and completed early in 1837, was blown down in the October hurricane of that year (1837). It was reconstructed and opened April 22, 1839.

As a matter of historical interest only, the brig *Elbe*, referred to above, was never repaired and hauled into water, but for many years served as Galveston's jail.

In October, 1842, Galveston was visited by a severe gale, the lowlands being flooded and considerable damage done to buildings and shipping.

The great September hurricane of 1854 did little damage to Galveston. The water came up on the floors of some of the stores on the strand, and the little steamer *Nick Hill* was wrecked.

Mr. Charles Trube, who has resided in Galveston for the past 66 years, told the writer several days ago that he distinctly remembers the hurricane of 1854. Confirming statements of early writers, he stated that one peculiar feature of the gale has been overlooked. Previous to the advent of the hurricane, Galveston was in the throes of a severe yellow fever epidemic. When the hurricane blew out the yellow fever went with it, those being ill recovering from the scourge and no new cases were reported.

On the night of October 2 and 3, 1867, Galveston was visited by a severe hurricane, which did much damage to the city and shipping. Quite a number of vessels were wrecked and the Galveston, Houston & Henderson Railway bridge across Galveston Bay was destroyed. A number of lives were lost, and the damage was estimated at a million dollars. The cemetery was inundated to such an extent that there could be no interments for 30 hours. This is the first mention of any bridge across Galveston Bay being destroyed.

Mr. Ousley states that on the 9th of June, 1871, Galveston was visited by an easterly gale, which reached its height at midnight, breaking the following morning. Considerable damage was sustained in the city and among the shipping, but no loss of life was reported.

Referring to pages 10 and 11 of the previous report, under dates of June 8 to 10, 1871, the presumption that the weather records on those dates indicated the proximity of a hurricane is verified.

On the 2d and 3d of October, 1871, Galveston was visited by a severe easterly blow, and the water flooded almost the entire city. The steamer *C. R. Hall* foundered in the upper bay and all hands were lost with the exception of one man. Several other vessels were wrecked.

Evidently the Galveston weather office overlooked this blow, as no mention was made of it in the early records.

Mr. Ousley has additional information regarding the hurricane of September 14–17, 1875, pages 11 and 12, in the previous report. He states that many houses in the city were wrecked and shipping in port was greatly damaged. "There were a number of men at Fort Point in Government employ," he states, "and their quarters were washed away and 13 of them drowned. Dr. Geo.

W. Peete, quarantine officer at the point, and his nephew were swept away and lost, and several persons in the city were killed. Along the upper bay there were a number of lives lost. Up to this date this had been the most destructive storm in the history of the Texas coast."

From this date to the present year the previous report contains all available data.

You will note big gaps in this record during the earlier part of the last century. While the island was occupied as early as 1817, it was abandoned in 1822, and only hunting and fishing and treasure-seeking parties visited the island for a number of years. As the entire Texas coast region was a wilderness, it can hardly be expected that hurricanes or storms should be chronicled during this period. Hurricanes may have occurred and the island and adjacent mainland may have been tide swept many times during that period without the phenomena being noticed, or at least being recorded.

Following the storm of August 15–17, 1915, Mr. Ben C. Stuart, of Beaumont, Tex., wrote a letter to Dr. B. Bunnemeyer, section director of the United States Weather Bureau, Houston, containing a list of hurricanes that have visited the Texas coast from the dawn of history to 1867. As this letter is very interesting it is given in full herewith:

While severe storms have swept the coast of Texas long before the dawn of history, the first authentic record we have dates from September 4, 1766, when, according to the Spanish chroniclers, a severe gale visited Galveston Bay. An Indian mission and presidio, called San Augustus de Ahumado, had been located in what is now Chambers County, and by investigation thought to have been situated on or near Lake Charlotte, which connects with the Trinity River just north of the present settlement of Wallisville. The wind greatly damaged the mission buildings, and the water from the bay and river submerged the land, which was only a few feet (probably 6 or 8) above ordinary tide. The disaster resulted in the abandonment of the mission. Lake Charlotte is 6 miles from the mouth of the Trinity River, and more than 50 miles from the Gulf of Mexico. The same spot was submerged during the hurricane of August 15–17, 1915.

As the coast of Texas was uninhabited for many years, save by roving bands of savages—the Opelousas near Sabine Lake and along Bolivar peninsula and the Carancahuas and Cokes from Galveston Island as far west as Aransas and probably to the vicinity of the Rio Grande—there is no record of hurricanes until the occupation of the island by Lafitte in 1817, and our information regarding it comes from statements made by James Campbell, who was in the service of Lafitte, and Col. Warren D. C. Hall, an officer under Gen. James Long, who was operating against the Spaniards and who visited Galveston Island to attempt to enlist Lafitte in the enterprise, but without success. According to them the island was visited by a severe hurricane, the wind being from the east and northeast and veering to the northwest. The exact date of the storm has not been preserved, but it was in September or October, 1818. The entire island was submerged with the exception of a small spot on the East end near the present site of the State Medical College. Lafitte's huts on shore were badly damaged and several of the vessels cast ashore or sunk. There is no record of the number of lives lost, if any.

From 1820 to 1836 there was no settlement on Galveston Island, although the Mexicans had built a small frame structure there in 1831 for a custom house, but it does not appear to have been used for any length of time. In 1821 settlers began to arrive, passing up the bay and located in the succeeding years at Harrisburg, Anahuac, and other points, but in none of the records of the period between 1821 and 1836 is there mention of any destructive hurricane on the Texas coast. This does not signify that there was none, but as all of the settlements, with very few exceptions, were inland they would not have felt its effect to the same extent as the island.

The year 1837 witnessed the beginning of Galveston, and by October several buildings were under construction. Immigrants were coming in, and there were 20 vessels in the harbor. There were no wharves, and the Mexican custom house was the only building on the island, the population being sheltered in tents or sod huts. On the 1st of October an easterly gale began blowing and continued with more or less intensity until the 6th, causing a very high tide and submerging most of the island. The wind then suddenly veered to the northwest and swept the waters of the bay down and across the island.

At this point Mr. Stuart has inserted the extract from the *Telegraph and Texas Register* of October 11, that year, giving an account of the hurricane. This is given in the forepart of this report. Continuing, Mr. Stuart says:

Col. Amasa Turner, who was present, wrote as follows: "There were about 30 vessels in Galveston Harbor when the great storm commenced on October 1, 1837. It began with a wind from the southeast and held to that quarter for three days; then it veered a little to the east and so continued until the sixth day, filling the bay very full and making a 4-foot rise at Houston. On the evening of the 6th the wind veered to the northeast and blew very strong. The schooner, *Tom Toby*, a privateer, parted her cable and went ashore at Virginia Point. About sunset the wind, veering all the time to the north and, if possible, increasing, brought the large volume of water from the bay onto the island with such force and violence as to sweep everything in its course. On land every house, camp, sod house, and inhabited structure was swept away except the old Mexican custom house. Only one of the vessels held its moorings."

On the 5th of October, 1842, another hurricane visited Galveston, but the wind was not so high as in 1837, nor the tide), although much of the town (then lower than at present) was flooded, and considerable damage to goods was sustained. The wooden Episcopal Church, on the southeast corner of Tremont and Winnie Streets, was blown from its blocks and badly wrecked. A number of other buildings were damaged and several small structures were demolished. No loss of life in the town was reported.

The great gale of September 16–19, 1854, which swept the Texas coast, did not inflict much damage at Galveston, its greatest force being felt to the westward. Of its effect at Galveston the *Civilian and Gazette* of September 19, said:

"An easterly gale began to blow last Saturday and has continued almost without interruption to the present time. The wind has not been severe, but, being from the quarter which always produces the highest tides, the waters of the Gulf and bay have been higher than we recollect since 1842. The floors of a number of stores on the Strand were overflowed during Sunday night, and considerable damage was done to such articles as were deposited on the floor. The little steamer *Nick Hill* was lost off Dollar Point."

The greatest force of this hurricane was felt at the town of Matagorda, to the westward of Galveston. Col. R. D. Parks, then residing there, but afterward at Temple, said: "It left a trail of disaster to be recorded in history. Hardly a house was left standing in the town site or vicinity." Another eyewitness says: "The storm at Matagorda was September 18, 1854. The water from the bay did not come over the town. Two people were killed. The steamer *Kate Ward* and crew were lost in Matagorda bay—from report it was said at Dog Island."

It is the writer's opinion that this was the hurricane that destroyed the settlement at Saluria, which was situated either on Bayucos island, lying between Espiritu Santo bay and Matagorda bay, or on an island that has merged with Matagorda island and before its merger was known as Saluria island. During the nine months the writer spent in that vicinity Bayucos island was called Saluria island by many. Other, some of them old residents in that section, stated that after the hurricane the channel separating Saluria and Matagorda islands disappeared. As various years were given in which the "big" hurricane occurred it is very likely that that section was affected by several of the storms that have been recorded on the Texas coast.

Continuing, Mr. Stuart says:

The great hurricane of August 10, 1856, was felt but little at Galveston, but L'Ille Dernier, or Last Island, a summer resort on the Louisiana coast, was engulfed with the loss of many lives. The steamer *Nautilus* from Galveston for New Orleans, with 30 passengers, however, ran into the gale and foundered, all hands being lost except a negro man who clung to a bale of cotton and was cast ashore on the Louisiana coast.

In the latter part of September, 1865, a hurricane struck the town of Calcasieu on the West Louisiana coast. The place was inundated and some 8 or 10 persons perished. As there was neither telegraph nor rail communication to that place, the report was brought to Galveston by the master of a lumber schooner.

On Wednesday, October 2, 1867, a strong easterly gale commenced blowing at Galveston, which shifted to the northeast during the night and on the morning of the 3d had attained a velocity estimated between 60 and 70 miles an hour. There was no weather bureau, and, of course, the figures were only guesswork. During the morning of the 3d the waters of the Gulf and bay rose rapidly until much of the city was flooded. The water from the north side came nearly up to Church Street at its highest elevation, while from the Gulf side it reached nearly to Broadway. The cemeteries at Fortieth Street and Broadway were inundated, and all the lowland down the island was covered with

water. Much damage was done to buildings in the city and more than 30 were destroyed. The lower floors of the stores on the Strand and Mechanic Street were flooded and their contents badly damaged. The brig *Ocean Wave*, from Philadelphia, was cast ashore on the beach near the present site of Fort Crockett, and her captain drowned. The bark *Palace* and the brig *Egarita* in the harbor were driven ashore, as were a number of small craft, and the steamboats *Alice M.* and *Sunflower* were wrecked. The trestle of the Galveston, Houston & Henderson Railroad between Eagle Grove and Virginia Point was completely wrecked, and communication was kept up by means of a ferry boat until after it was rebuilt, which was not done for several months. There were three lives lost and the property damage was estimated at $1,000,000, including that to the vessels. As previously stated, the gale began from the eastward on October 2d, the wind veering to the northeast during the night and continuing from that quarter until about 2.30 on the afternoon of the 3d, when it lulled temporarily, to veer from the northwest, from which point it blew strongly for a short time, the waters receding rapidly, and by 5 o'clock the sky was clear and the wind of only moderate velocity. This hurricane cut a channel 5 feet deep through the low sand flat east of Sixth Street from the bay to the Gulf, which remained open for only a few months. It also did much damage at the mouth of the Rio Grande and at Brownsville.

With reference to this last it is the writer's recollection that it was this hurricane that destroyed the towns of Bagdad and Clarksville, situated opposite each other at the mouth of the Rio Grande.

Some years ago, when in that section, the stories woven about their destruction were often told the writer. During the war between the States those towns sprung into prominence because of the cotton running that was being done through them. One being situated on Texas soil and the other on Mexican soil, made it comparatively easy for the State to get its cotton to foreign ports. Both towns were swept away shortly after the war and it must have been during the hurricane of 1867.

Between the dates of June 1 and June 4, 1871, evidently a hurricane passed in the vicinity of Galveston.

On June 1 the journal records that the barometer was falling with a light northeast wind, and on June 2 mention was made of an exceptionally heavy sea.

On June 3 the barometer at 7 a. m. was 29.61, and at 4 p. m. the wind attained a velocity of 38 miles from the east, shifting to northeast at 4.36 p. m., with a continued velocity of 28 miles per hour. The rainfall amounted to 3 inches, and on June 4 the barometer stood at 29.51 inches. This is practically the entire record for their period.

On June 8 of the same year there is another entry of the wind falling to 10 miles per hour and the barometer falling. On the following day there was a heavy sea with the barometer 29.53 and a maximum wind velocity of 49 miles per hour from the northeast at 4.30 p. m., which destroyed all weather instruments on the roof. The wind attained an estimated velocity of 60 miles per hour.

On June 10 the journal contained the meager entry, "Barometer rising." Without doubt this was a hurricane that entered the coast close below Galveston or passed in the Gulf in the vicinity of the city.

On July 14, 1874, a waterspout was observed 1 mile off the south beach of the city, which passed inland and broke when it reached the sand. Another waterspout was reported out to sea at the same time.

On September 3, 1874, storm warnings were received at the Galveston office, and on September 5 an unusually high tide was recorded with the wind east, and the journal makes mention of the fact that the people were apprehensive of an overflow.

On September 6 the journal bears entry that there was considerable excitement in the city over the dread of an overflow from the unusually high tide that prevailed, but the danger passed with little damage to the city.

September 14, 1875, the barometer was reported falling with a brisk wind from the northeast.

September 15 the barometer continued falling rapidly with a wind northeast, which attained a velocity of 41 miles per hour at 9.30 p. m.

September 16 the barometer continued to fall and at 9:49 p. m. had fallen to 29.40. The wind continued from the northeast, with velocities varying from 33 to 36 miles per hour.

September 17 the barometer fell to 29.03 at 2 p. m., with a 40-mile wind, which blew away the anemometer and other weather instruments. A new anemometer was put up, which recorded a wind of 60 miles, when it was again blown away. The entire island was covered with water and the center of the hurricane evidently passed very near the city. During the day of the 17th the wind suddenly shifted to the southeast and south, and, according to old residents that were interviewed, the water from the bay swept away several blocks of land from the east end of the island.

The center of this hurricane passed below Galveston and did considerable damage to points on the lower coast. The town of Indianola, on Matagords Bay, below Port Lavaca, was practically swept away. One hundred and seventy-six people were killed and three-fourths of the houses and buildings were washed away. The maximum wind registered at this point was 88 miles per hour when the weather observatory was destroyed and the observer killed. The estimated velocity was above 100 miles per hour. The damage in the vicinity of Indianola was estimated at more than $1,000,000.

On October 19, 1876, a hurricane was reported in the Gulf just east of Galveston, moving in a westerly direction. Galveston had a 24-mile wind with a fair tide, but on the following day the hurricane recurved and passed eastward.

SYSTEMATIC CORRECTIONS TO THE CALAMA, CHILE, SOLAR CONSTANT VALUES.

By C. G. ABBOT, Assistant Secretary.

[Smithsonian Institution, Washington, D. C., Sept. 22, 1921.]

As stated in the MONTHLY WEATHER REVIEW for February, 1919, when the regular publication of the solar constant values observed in Chile by the Smithsonian expedition was begun, the values published were regarded as preliminary. That is to say, the results were given just as they were received from the field, and it was not until a considerable body of the South American solar-constant values were available that a general survey of them could be taken in order to have a basis for the determination and correction of such systematic errors as might appear. The occupation of the station at Calama having ceased on July 26, 1920, with the removal of the station to Mount Montezuma, the whole body of the Calama results can now be examined from a general point of view for the purposes just mentioned.

First of all, it was desirable to determine whether the solar-constant values were in correlation with the prevailing atmospheric humidity. Such a correlation, as readers of Volume III of the *Annals of the Astrophysical Observatory* will find described at page 43, was discovered in the Mount Wilson observations by grouping the solar-constant values between certain limits of precipitable water prevailing in the atmosphere, as determined by Fowle's method. In discussing the Calama results, the logarithm of the ratio ρ/ρ_{sc}—that is to say, the logarithm of the depression of the curve at the water vapor band ρ—was used as the function of atmospheric humidity. The values of the solar constant were grouped with respect to this variable, with the following results:

Influence of atmospheric humidity on Calama solar-constant values.

[Observations of July 27, 1918, to June 30, 1919. Long method only (bolographic).]

Number of observations	22	20	32	35	37	34	38	26
Mean log ρ/ρ_{sc}	1.510	1.573	1.631	1.673	1.726	1.774	1.828	1.867
Mean solar constant	1.9392	1.9447	1.9426	1.9485	1.9362	1.9373	1.9516	1.9550

[Observations of July 1, 1919, to July 26, 1920. Long method only (bolographic).]

Number of observations	17	19	20	14
Mean log ρ/ρ_{sc}	1.497	1.663	1.749	1.830
Mean solar constant	1.9506	1.9504	1.9474	1.9525

The range of water vapor prevailing at Calama is nearly, but not quite, as great as that which has prevailed at Mount Wilson, but the march of the mean solar-constant values with respect to the logarithm of ρ/ρ_{sc} does not appear to indicate with any certainty that there is any correlation between these quantities. We have not felt justified, therefore, in introducing any secondary correction for the prevailing humidity at Calama similar to the secondary correction which is applied for this purpose to the Mount Wilson results. Accordingly, the values of the solar constant determined by the fundamental or long method at Calama will stand as heretofore published, so far as we can now predict.

Turning now to the values determined by the empirical or short method, whose dependence on the long fundamental method has been described in this REVIEW for August, 1919, the accuracy of the short method results evidently depends upon the accuracy of the curves which have been drawn connecting the values of the function ρ/ρ_{sc} with the atmospheric transmission coefficients determined by many long method observations. The different parts of this curve were determined with very different degrees of certainty. For those regions where the value of the function was small and which corresponded to clear dry days, there were so many observations by the long method available as their basis that these parts of the curve are not likely to be seriously in error.

Not so for the regions of the curve corresponding to very large values of the function—that is, to skies of great haziness associated with high atmospheric humidity. At such times solar-constant values by the long method are seldom obtained, and when obtained are liable to be in error, due to change in the transparency of the atmosphere during the several hours required for the long-method determinations. It seems, therefore, particularly desirable to determine whether the short-method results appear to be systematically in error for different values of the function.

It will be recalled that the short-method solar-constant values are computed by the aid of three sets of curves—one set corresponding to observations at air mass 3, another at air mass 2, and the third at air mass 1.5. In the study of the matter we therefore gathered all of the solar constant values, first, into the three divisions corresponding with the three sets of curves from which these divisions were severally determined. Secondly, in each of these grand divisions we divided the solar constant values into groups between different limits of the function values. While the high and low function values are prevailingly associated with special seasons of the year, yet a very fair distribution of them occurs over the entire annual period. Accordingly, when a large group of, say, 20 to 50 solar-constant values is selected, corresponding to functions values between certain narrow limits, this group of solar-constant values covers a great variety of days fairly representative of the whole year. The mean of such a group will be very little subject to fluctuation owing to the real variability of the sun. Hence, we made the assumption that the mean values of the groups within the 13 months, July, 1919, to July, 1920, inclusive, should be identical, and should be identical with the mean value of the solar-constant values scattered through this interval of time which were determined by the long method.

The latter value was found to be 1.951 calories per square centimeter per minute. Accordingly, the deviations of the mean values for the various groups from the standard values, 1.951, were regarded as an indication of the amount of error due to the employment of defective function-transmission curves within the various limits of the several groups.

This system of deviations having been plotted with respect to the values of the functions corresponding, a correcting curve was thereby obtained for short-method observations taken at Calama by each of the three sets of curves corresponding respectively to air masses 3, 2, and 1.5. In the following table are given, in illustration, the results of the discussion for air mass 2.

Dependence of solar constant on function values.

[Calama observations July 1, 1919, to July 26, 1920. Short method only (pyranometer). From curves for air mass 2.0.]

Number of observations.	66	95	41	27	20	14	24
Mean value of function	174	243	340	450	586	780	1,151
Mean solar constant	1.9451	1.9432	1.9452	1.9566	1.9630	1.9791	1.9832

In drawing the curve for correcting the solar-constant values, it was thought best to err on the side of minimizing rather than of emphasizing the correction where the divergence of the observed corrections from the smooth curve would tend to raise a doubt as to the best course to pursue. Accordingly, the corrections which have been applied are thought to be, if anything, slightly less in magnitude than perhaps would be advisable. However, the magnitudes of the corrections are in all cases small, and the defect in the corrections, if any, is certainly in a high degree negligible.

On this basis we have corrected each individual value for the solar constant obtained by the short method from July 1, 1919, to July 26, 1920. Data were lacking to apply the corrections for the very few days of June, 1919, when the short method was employed. However, the corrections at that season of the year were generally very small, so that this is of little consequence.

In the following table we give the original and corrected weighted mean values of the solar constant for the period in question, extending from July 1, 1919, to July 26, 1920. All other values of the solar constant observed at the station at Calama are to be regarded, at least for the present, as standing unchanged.

With regard to the solar-constant values which have been obtained at the station at Montezuma, hitherto we have not been able to assure ourselves that any correction is to be applied to them, either for the long-method or the short-method results. We prefer to wait for some time further before deciding whether or not any systematic corrections to these values must be applied.

Date.	Weighted mean solar constant values.	
	Original.	Corrected.
1919.		
July 1	1.935	1.942
2	1.918	1.925
3	1.922	1.928
4	1.968	1.980
6	1.964	1.971
9	1.947	1.954
10	1.951	1.958
11	1.946	1.954
12	1.949	1.951
13	1.934	1.941
14	1.953	1.965
15	1.952	1.960
17	1.955	1.959
18	1.966	1.972
19	1.979	1.987
20	1.952	1.961
21	1.953	1.957
22	1.960	1.971
23	1.959	1.967
24	1.951	1.955
25	1.960	1.967
26	1.918	1.922
27	1.916	1.925
28	1.955	1.959
29	1.951	1.958
30	1.928	1.936
31	1.915	1.930
Aug. 1	1.953	1.959
2	1.935	1.943
3	1.971	1.980
4	1.954	1.959
5	1.953	1.963
6	1.936	1.943
7	1.954	1.962
8	1.953	1.961
9	1.970	1.980

Date	Weighted mean solar constant values.	
	Original.	Corrected.
1919.		
Aug. 10	1.958	1.960
11	1.932	1.939
13	1.920	1.924
14	1.948	1.946
15	1.953	1.950
16	1.929	1.932
17	1.947	1.955
18	1.951	1.962
19	1.918	1.927
20	1.935	1.943
21	1.930	1.934
22	1.960	1.966
23	1.953	1.961
24	1.958	1.964
25	1.954	1.962
26	1.938	1.945
27	1.945	1.954
28	1.949	1.957
29	1.961	1.996
30	1.943	1.451
31	1.934	1.925
Sept. 1	1.930	1.937
2	1.912	1.918
3	1.926	1.934
4	1.941	1.946
5	1.929	1.938
6	1.937	1.946
7	1.933	1.941
8	1.943	1.956
9	1.931	1.937
10	1.921	1.930
11	1.941	1.948
12	1.915	1.917
13	1.948	1.956
14	1.922	1.930
15	1.926	1.933

Date.	Weighted mean solar constant values.	
	Original.	Corrected.
1919.		
Sept. 17	1.933	1.932
18	1.939	1.948
19	1.949	1.957
20	1.948	1.957
21	1.950	1.957
22	1.918	1.925
23	1.938	1.941
25	1.920	1.928
26	1.951	1.957
27	1.919	1.928
28	1.930	1.938
29	1.934	1.935
30	1.918	1.926
Oct. 2	1.944	1.944
7	1.891	1.898
8	1.963	1.971
9	1.948	1.957
10	1.961	1.961
11	1.952	1.948
12	1.949	1.918
13	1.946	1.945
14	1.940	1.952
15	1.959	1.968
17	1.934	1.939
19	1.955	1.960
20	1.953	1.962
21	1.965	1.972
23	1.946	1.946
24	1.962	1.959
25	1.954	1.938
26	1.971	1.964
28	1.957	1.954
31	1.958	1.954
Nov. 1	1.957	1.964
2	1.957	1.958
3	1.957	1.958
4	1.960	1.961
5	1.969	1.973
6	1.952	1.949
7	1.944	1.953
9	1.948	1.949
10	1.960	1.960
11	1.966	1.960
12	1.961	1.957
13	1.960	1.953
15	1.947	1.941
17	1.925	1.929
18	1.961	1.968
21	1.954	1.952
22	1.949	1.940
23	1.951	1.945
24	1.952	1.942
25	1.944	1.943
26	1.968	1.968
27	1.936	1.928
28	1.957	1.956
29	1.952	1.952
30	1.956	1.958
Dec. 1	1.957	1.958
3	1.958	1.951
5	1.950	1.952
6	1.943	1.925
7	1.934	1.927
8	1.944	1.928
9	1.965	1.963
10	1.955	1.945
12	1.957	1.951
15	1.951	1.954
16	1.945	1.937
17	1.965	1.951
18	1 985	1.968
19	1.960	1.946
20	1.948	1.938
21	1.948	1.939
22	1.969	1.955
23	1.967	1.951
24	1.972	1.959
25	1.978	1.965
26	1.987	1.987
27[1]	1.807	1.807
28	1.994	1.974
29	1.964	1.957
31	1.979	1.967
1920.		
Jan. 2	1.970	1.969
3	1.976	1.967
4	1.964	1.960
5	1.964	1.960
7	1.977	1.949
10	2.027	2.002
11	1.979	1.975
12	1.955	1.950
14	1.962	1.956
15	2.000	1.984
17	1.995	1.987
18	1.981	1.963
19	1.989	1.978
20	1.947	1.946
21	1.954	1.929
22	1.973	1.963

Date.	Weighted mean solar constant values.	
	Original.	Corrected.
1920.		
Jan. 23	2.001	1.986
24	1.998	1.973
25	1.978	1.961
26	1.958	1.948
27	1.975	1.959
28	1.973	1.957
29	1.963	1.959
30	1.976	1.968
31	1.975	1.949
Feb. 6	1.974	1.963
7	1.946	1.931
8	1.953	1.945
9	1.982	1.960
10	1.994	1.992
11	1.958	1.953
12	1.977	1.969
13	1.962	1.955
14	1.951	1.932
15	1.951	1.942
16	1.973	1.953
18	1.971	1.961
19	1.983	1.959
20	1.982	1.967
24	1.967	1.957
25	1.987	1.969
26	1.983	1.954
27	1.967	1.958
28	1.953	1.943
Mar. 1	1.980	1.973
2	2.000	1.979
3	1.980	1.957
5	1.949	1.939
6	1.973	1.964
7	1.971	1.961
8	1.956	1.946
10	1.959	1.950
11	1.978	1.969
12	1.981	1.961
13	1.959	1.945
14	1.962	1.953
15	1.969	1.969
16	1.965	1.956
17	1.962	1.943
18	1.954	1.936
19	1.940	1.930
20	1.931	1.922
21	1.941	1.920
22	1.927	1.923
23	1.866	1.846
24	1.905	1.887
26	1.953	1.934
27	1.966	1.969
28	1.958	1.967
29	1.969	1.969
30	1.951	1.948
31	1,957	1.954
Apr. 1	1.944	1.938
2	1.960	1.953
3	1 956	1.955
4	1.962	1.969
5	1.960	1.961
6	1.925	1.923
7	1.916	1.923
8	1.927	1.934
9	1.960	1.964
10	1.961	1.965
11	1.958	1.962
12	1.955	1.956
13	1.954	1.959
14	1.957	1.960
15	1.944	1.953
16	1.935	1.954
17	1.946	1.953
18	1.953	1.957
19	1.948	1.950
20	1.958	1.961
21	1.937	1.933
22	1.949	1.953
23	1.950	1.950
24	1.948	1.949
25	1.949	1.947
26	1.960	1.963
27	1.949	1.955
28	1.943	1.939
29	1.972	1.976
30	1.959	1.959
May 1	1.933	1.934
2	1.948	1.957
3	1.961	1.965
4	1.957	1.962
5	1.938	1.945
6	1.949	1.951
7	1.952	1.955
8	1.957	1.965
9	1.921	1.923
10	1.938	1.941
11	1.968	1.971
12	1.952	1.962
13	1.955	1.963
14	1.937	1.952

[1] This long-method value is known to be worthless because of evident progressive deterioration of the atmospheric transparency.

Date.	Weighted mean solar constant values.	
	Original.	Corrected.
1920.		
May 16	1.957	1.963
17	1.945	1.952
19	1.959	1.959
20	1.961	1.964
21	1.930	1.936
22	1.934	1.939
23	1.939	1.942
24	1.938	1.942
25	1.963	1.970
26	1.914	1.921
27	1.959	1.964
28	1.948	1.952
29	1.940	1.942
30	1.977	1.986
31	1.946	1.952
June 1	1.933	1.937
2	1.938	1.942
3	1.956	1.968
4	1.926	1.929
5	1.955	1.960
6	1.945	1.951
7	1.933	1.938
8	1.924	1.929
9	1.936	1.940
10	1.929	1.933
11	1.937	1.943
12	1.918	1.924
13	1.935	1.939
14	1.910	1.917
15	1.926	1.929

Date.	Weighted mean solar constant values.	
	Original.	Corrected.
1920.		
June 18	1.933	1.941
19	1.941	1.942
23	1.939	1.947
24	1.941	1.942
25	1.914	1.921
26	1.948	1.951
27	1.918	1.925
30	1.940	1.939
July 1	1.936	1.944
2	1.944	1.949
3	1.929	1.935
4	1.942	1.948
5	1.950	1.955
6	1.949	1.948
7	1.942	1.948
8	1.945	1.951
9	1.941	1.944
10	1.927	1.932
11	1.938	1.945
12	1.938	1.944
15	1.925	1.933
18	1.921	1.933
19	1.920	1.932
20	1.942	1.950
21	1.953	1.965
22	1.946	1.947
24	1.943	1.950
25	1.936	1.943
26	1.943	1.950

SOLAR CONSTANT AND SUN SPOTS.

By A. ÅNGSTRÖM.

[Abstract reprinted from *Meteorologische Zeitschrift*, Aug., 1921, pp. 250-251.]

In the *Geografiska Annaler* [1] there is given an instructive coordination of the Abbot solar-constant values and the relative sun-spot numbers of Wolfer for the years 1905 to 1917. The values are the annual means.

Year	Sun spot number N.	Solar constant S.	
		Observed.	Calculated.
1905	63	1.956	1.946
1906	58	1.942	1.945
1907			
1908	55	1.936	1.944
1909	46	1.918	1.940
1910	21	1.921	1.928
1911	3	1.921	1.922
1912			
1913	1	1.904	1.909
1914	9	1.956	1.919
1915	62	1.952	1.946
1916	50	1.946	1.942
1917	113	1.960	1.961

A high sun-spot number implies a high solar constant. The coefficient of correlation between S and N Ångström calculates to be 0.64 ± 0.12. A better agreement is found, however, between the solar constant and the square root of the spot number. Here the correlation coefficient is 0.754 ± 0.09. This relation is important, for it indicates that the square root of the sun-spot numbers is a better index of solar activity than the numbers themselves. For the relation between S and N, Ångström finds the following formula: $S = 1.93 + 0.0055\sqrt{N}$ gram-calories; with this formula the column in the table headed "Calculated" is determined.

Ångström adds with foresight that by no means does the agreement in a sun-spot period persist so that one may speak with assurance, although the validity of the relation appears very probable.—*F. M. E.*

[1] 1920, 2: 162.

SUPPLEMENTAL NOTE ON FREE-AIR TEMPERATURE AT DREXEL AND ELLENDALE DURING THE WARM SUMMER OF 1921.

In this REVIEW for July, 1921, page 387, reference was made to the high free-air temperatures as obtained by kites at the two stations above named during the abnormally warm winter of 1920–21. The observations for August, 1921, are now available. These, like those for the preceding month, show that the temperature, from the surface up to 1,000 meters above sea-level, was slightly below the average and that above this level the temperature was higher than the average. Thus it appears that the free-air temperature above the stations named has been above the average for three successive months, particularly in June.

In previous studies it has been shown that abnormalities in the surface distribution of temperature are reflected in the free air up to a considerable height, probably to 5 km., although the kite observations at that level are not numerous. The natural explanation of the high temperature seems to be analogous to the one governing the surface distribution—viz, insolation plus transportation of heated air from lower latitudes. Through the courtesy of the Aerological Division, I am able to present the table below, which shows the average resultant free-air winds at successive levels in steps of 500 meters up to the greatest height reached by the kites at the stations above named for June, and also for comparison therewith the resultant winds for June, 1921.

TABLE 1.—*Resultant winds (average and for June, 1921) in free air at Drexel, Nebr., and Ellendale, N. Dak.*

[The Drexel average is for five years; Ellendale is for three years.]

	Altitude (meters above sea level).					
	396	444	1,000	1,500	2,000	2,500
Drexel:						
5-year average	S. 19° W.	.....	S. 46° W.	S. 69° W.	S. 72° W.	S. 83° W.
June, 1921	S. 7° E.	.....	S. 11° W.	S. 16° W.	S. 20° W.	S. 10° W.
Ellendale:						
3-year average	.....	N. 73° E.	S. 31° E.	S. 54° W.	S. 66° W.	S. 82° W.
June, 1921	.....	S. 25° E.	S. 10° W.	S. 26° W.	S. 36° W.	S. 40° W.

	Altitude (meters above sea level).				
	3,000	3,500	4,000	4,500	5,000
Drexel:					
5-year average	S. 89° W.	N. 89° W.	N. 78° W.	N. 67° W.	N. 51° W.
June, 1921	S. 26° W.	S. 14° W.	S. 30° E.	S. 40° E.	N. 68° E.
Ellendale:					
3-year average	N. 89° W.	N. 87° W.	N. 75° W.	N. 70° W.	.....
June, 1921	S. 41° W.	S. 18° W.	S. 23° W.	N. 45° W.	.....

The striking feature of the table is the fact that southerly winds prevailed up to a level about 1,000 meters higher than the average, and as a consequence the lower limit of the northerly winds, which on the average prevail down to the 3,500-meter level, was elevated somewhat. May it not be assumed that the effect of the unusual warmth in June was cumulative during July and August, and that there is a considerable lag in the temperature of the free air as compared with the surface air?—*A. J. Henry.*

NOTES, ABSTRACTS, AND REVIEWS.

INTERNATIONAL EXPLORATION OF THE UPPER AIR.

[Reprinted from *London Times;* reprinted in *Science*, New York, Sept. 23, 1921, p. 268].

International exploration of the upper air dates from 1896, when a conference took place at Petrograd. Methods of sounding the atmosphere, even to a height of 23 miles, were devised. By the use of drifting free-balloons and recording instruments carried up by kites and anchored balloons an unexpected stratification of the atmosphere has been disvovered. The temperature falls regularly up to a height averaging six or seven miles from the ground, lower over the Equator, higher near the poles. * * *

Little is known as to the cause of this disposition, and less as to the influences it must have on other factors of wind and weather. Useful knowledge can be gained only from data obtained by the same methods at the same times at the largest possible number of stations. International cooperation is necessary. It was interrupted by the war, although all the combatants made extensive use of the meteorological methods for the practical objects of artillery, aviation, poison gas, and sound-ranging. It has now been resumed. The other day we gave an account of the proceedings of the first meeting since the war, held at Bergen in the last week of July, under the presidency of Prof. V. Bjerknes. The name of that distinguished meteorologist is associated with a new theory of the weather in temperate latitudes, on which we commented a year ago. The theory briefly is that just as the poles are capped with snow, so they are capped by a great mass of cold air. In a wavering line round each temperate zone this polar air meets the warm air from the Equator abruptly. Along the front of contact the warm rises over the cold stream. Cyclones and anticyclones are born of the contest. The professor urges the formation of a closely-set chain of observing stations round the globe in the zone of struggle. Other meteorologists are more disposed to assign the causes of our weather to the vaster regions of the upper air. An international meteorological committee, to meet in London in September, has been appointed by the Commission, and is to give special attention to the polar theory. The progress of its labors will be followed with deep interest. There are few human activities which would not gain by the advance of meteorological science, and the future of aviation will be largely determined by it.

MEETING OF THE INTERNATIONAL COMMISSION FOR THE SCIENTIFIC INVESTIGATION OF THE UPPER AIR AT BERGEN.

The *Meteorological Magazine*, for September, 1921, contains a brief summary, prepared by Col. Gold, of the meeting of the International Commission for the Scientific Investigation of the Upper Air, held at Bergen, July 25–26, 1921. The meeting, held under the direction of the president of the Commission, Prof. V. Bjerknes, was devoted more to the discussion of scientific problems and less to business details than was that previous meeting held in Vienna, in 1912.

Mr. J. Bjerknes gave a summary of the Scandinavian work on the polar front, in which it has been concluded that, "Broadly speaking, depressions occur in families of four, each following a track slightly further south than its predecessor, and the first and third of the family generally more intense than the second and fourth. On the average a new family begins every six and one-fourth days."

A discussion of the times for international sounding balloon ascents was another important phase of the conference, and the decision was that there should be normally 24 ascents each year; that 12 of these should be daily made in two separate series of six days; that 6 should be 12 hourly made in three continuous days; and that the remaining 6 should be arranged by the president of the Commission. It was agreed that sounding-balloon data should be published graphically, with supplementary tables, pressure and temperature being given. No decision was reached regarding the publication of pilot-balloon data, and the matter was left to the bureau of the Commission for decision.

In conclusion, Col. Gold says: "The meeting was scientifically stimulating—how, indeed, could one be otherwise than stimulated by the director (Devik) of an observatory (Haldde) where winds of 130 miles per hour (average for 10 minutes) have been recorded by an anemometer which had to be especially strengthened to prevent it being blown away?"—*C. L. M.*

MERCURIAL BAROMETER FOR AIRSHIPS.

[Reprinted from *The Meteorological Magazine*, Aug., 1921, pp. 193-194.]

To meet the needs of the large rigid airships a mercury aerial barometer has recently been designed by the Instrument Department, Air Ministry, and constructed by Messrs. Negretti and Zambra. * * *

The barometer is of the Kew type and is supported on gimbal bearings from a bracket attached to the framework of the airship in such a way that the column may remain vertical with the supporting bracket inclined at 20° to the vertical in any direction. Two dashpots are provided to damp out any swinging of the instrument. These consist of cylinders which are attached to the back of the mercury cistern and carry loosely fitting pistons suspended by ball joints from the supporting bracket; the cylinders are filled with a mixture of glycerine and water.

The mercury column is of large diameter, 0.5 inch, to eliminate the necessity for any correction for capillarity, while to avoid any inaccuracies due to the fact that the pressure in the control car is very rarely static,[1] the mercury cistern is not directly open to the atmosphere, but is connected to the static tube of a hanging head slung some 30 feet below the ship, and therefore clear of any disturbance due to the passage of the ship through the air. The nipple to which the static head is connected is fixed to the supporting bracket, and a rubber tube leads therefrom to a stopcock on the cistern, thus avoiding any restraint on the swinging of the barometer.

The end of the barometer tube which dips into the mercury in the cistern is nearly closed by a conical plug, the exact position of which may be adjusted by a screw. By use of this device any oscillations of the mercury column may be damped out, or, again, the column may be restrained in any one position at will for a reading to be made at leisure. Moreover, to facilitate transport of the instrument the column may be pumped down and the plug closed.

[1] The static pressure is the pressure in the free atmosphere at the same level. If a tube with holes in its sides is set in such a way that the air can stream past it without being obstructed, the pressure inside the tube is equal to the static pressure.

The right-hand side of the barometer carries a pressure scale graduated in millibars; the vernier has a coarse adjustment by sliding and a fine adjustment by rack and pinion operated from the knurled knob seen just beneath the gimbal ring.

The left-hand side of the column carries a movable scale showing heights in feet. This scale is graduated according to the usual convention to be correct for all heights when the air pressure is 1013.2 mb. at the zero height and the air temperature is uniformly 50° F. For convenience of use in landing and in other operations the height scale may be adjusted by means of the knurled knob on the left of the column to place its zero opposite any desired pressure. This height scale is intended as a rough guide when quick readings are called for; for accurate estimates of height it is necessary to use the pressure readings in conjunction with temperature observations.

VARIABILITY OF TEMPERATURE IN VALLEYS AND ON MOUNTAIN TOPS.

By H. FICKER.

[Abstracted from *Meteorologische Zeitschrift*, Aug., 1921, pp. 243-244.]

A study covering five years of record for Munich, Peissenberg, and the Zugspitze,– a plain station, a peak rising abruptly from the plain, and an Alpine peak, respectively, reveals the following values for the daily variability of temperature:

Station.	Altitude.	Variability.				
		Winter.	Spring.	Summer.	Autumn.	Year.
	m.	°*C.*	°*C.*	°*C.*	°*C.*	°*C.*
Munich	526	2.83	2.27	1.94	2.29	2.33
Peissenberg	994	2.84	2.72	2.72	2.32	2.65
Zugspitze	2,964	3.37	2.71	2.14	2.28	2.63

It will be seen that in the annual mean, the Peissenberg shows as great a variability as the Zugspitze, although usually variability increases with altitude. In lower layers the cold stagnant air clinging closely to the surface prevents the breaking through of warm foehn winds and hence the variability is not so great. The anomaly of the Peissenberg maximum in summer is difficult to explain, and it would be necessary to investigate a number of similarly located stations to arrive at the cause. In studying stations lying intermediate in altitude to these, there arise other difficulties in determining a law for the decrease of temperature with altitude on the surface.—*C. L. M.*

TEMPERATURE RÉGIME IN CAVERNS.[1]

By A. ROSCHKOTT.

[Abstract reprinted from *Science Abstracts*, Aug. 31, 1921, §1386, pp. 548-549.]

A critical and historical account of contributions to the above subject. The problem to which attention was first devoted was the observed persistence of ice in some caverns, even during the period when the outside temperature is above the freezing point. Many theories were advanced only to prove untenable. Real progress was not made until Crammer transferred attention to the régime of air temperature in caverns in relation to the form of the cavern (the persistence of ice in some cases then following as a corollary), and an account is given of the main results of his work and of the later mathematical work of Bock. Caverns are of two main types—(1) having only one entrance, (2) having two or more entrances. Further subdivisions of (1) is made according as the cavern (*a*) lies horizontally, (*b*) leads upward, (*c*) leads downward; and of (2), according as the entrances are (*a*) at the same level, (*b*) at different levels. Each type has its own characteristics, (1 *c*) being, for example, the "ice pockets" owing to the ease with which cold air may penetrate them when temperature is lower outside, in contrast with the stability of the cold air within, when the air outside is warm. Little has been written on the subject in meteorological literature, and the author has drawn on other sources. It is pointed out, however, that caverns provide laboratories in which many meteorological problems may be studied, *e. g.*, eddy diffusion, in the absence of radiation complications.—*M. A. G.*

[1] *Meteorologische Zeitschrift*, Feb., 1921, 38: 33-38.

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SOLAR OBSERVATIONS.

SOLAR AND SKY RADIATION MEASUREMENTS DURING AUGUST, 1921.

By HERBERT H. KIMBALL, Meteorologist.

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements the reader is referred to this REVIEW for April, 1920, **48**:225.

From Table 1 it is seen that direct solar radiation intensities were close to normal August values at all the stations, and Table 2 shows that the total solar and sky radiation received on a horizontal surface was above the August normal, the excess averaging about 7 per cent at Washington and 4 per cent at Madison.

Skylight polarization measurements made on five days at Washington give a mean of 54 per cent and a maximum of 61 per cent on the 22d. At Madison, measurements obtained on 13 days give a mean of 57 per cent and a maximum of 70 per cent on the 8th. These are average values for August at Washington, but slightly below average at Madison.

TABLE 1.—*Solar radiation intensities during August, 1921.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance. 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon.
	75th meridian time.	Air mass. A. M.					P. M.				Local mean solar time.
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Aug. 3	17.96			0.58	0.75	0.99	1.32				18.59
9	11.81						1.21				9.47
10	14.60						1.15				12.68
15	8.48							0.98			7.87
18	16.79					1.05	1.21				14.10
19	13.61					1.04	1.18				12.24
22	8.81				0.91	1.09					8.48
26	11.81	0.47	0.60	0.75			1.18				9.14
27	10.97	0.61	0.72	0.85	1.00		1.30				8.48
30	17.96						1.25	0.90	0.68	0.57	0.48	15.11
31	16.79					0.85	1.03					16.20
Means		(0.54)	0.63	0.82	1.00	1.20	(1.02)	(0.85)	(0.57)	(0.48)	
Departures		−0.03	+0.04	+0.07	+0.09	−0.03	+0.05	+0.03	−0.02	−0.04	

Madison, Wis.

Aug. 4	12.24				1.04	1.34					12.24
6	10.97			0.92	1.11	1.44					7.87
7	8.81				1.22						8.18
8	7.87				1.19						7.87
11	17.96				0.94						16.20
18	14.10					1.35	1.14	0.93			11.38
19	13.13			0.84	1.03	1.29					18.59
20	10.59			1.06	1.22	1.40					9.83
21	10.59			1.05	1.21						8.18
23	10.21				0.81	1.04					14.10
24	16.20					1.16	0.79	0.54			16.79
25	15.65					1.09	0.81				14.10
27	16.79					1.37					15.65
28	15.65				0.83	1.29					17.37
29	16.20					1.11					19.89
30	19.23			0.62	0.79	1.01					21.28
Means				0.90	1.04	1.24	0.91	0.74			
Departures				−0.02	−0.04	−0.06	−0.12	−0.11			

* Extrapolated.

TABLE 1.—*Solar radiation intensities during August, 1921*—Continued.

Lincoln, Nebr.

Date.	Sun's zenith distance. 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th meridian time.	Air mass. A. M.					P. M.				Local mean solar time.
	e.	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Aug. 3	11.38			0.75	1.15						13.39
8	10.97			1.03	1.19			0.90	0.78	0.65	16.20
9	13.61		0.73	0.84	0.98	1.29					21.28
11	15.11							0.79	0.68		15.11
12	13.61				1.03		1.00	0.82	0.70	0.60	18.59
17	12.24		0.77	0.98	1.17	1.36	1.11	0.92	0.80	0.64	13.61
18	12.68		0.79	0.93	1.13	1.28	1.05	0.88	0.66	0.63	17.96
22	17.37					1.35	1.05	0.82	0.65	0.57	14.60
24	19.89					1.30	0.99	0.91	0.69	0.56	17.37
25	5.26		0.70	0.84	1.04	1.27	0.90	0.73			19.89
27	17.96					1.39	1.07	0.89	0.76	0.65	20.57
31	16.20			0.89	1.09	1.41					18.59
Means			0.75	0.89	1.10	1.33	1.02	0.85	0.72	0.61	
Departures			−0.04	±0.00	+0.03	−0.01	−0.07	−0.05	−0.04	−0.08	

Santa Fe, N. Mex.

Aug. 10	9.14					1.48					9.14
17	6.76		1.11	1.23	1.36	1.51					6.27
20	9.14	0.94	1.04								9.83
22	8.18		1.08								8.18
25	9.47		1.00	1.11	1.26						8.48
26	7.57		1.02	1.15	1.30	1.47					7.29
27	7.29	0.86	0.98	1.12	1.27	1.46					7.87
Means		(0.90)	1.04	1.15	1.30	1.48					
Departures		−0.02	+0.05	+0.05	+0.05	+0.03					

TABLE 2.—*Solar and sky radiation received on a horizontal surface.*

Week beginning.	Average daily radiation. Washington.	Madison.	Lincoln.	Average daily departure for the week. Washington.	Madison.	Lincoln.	Excess or deficiency since first of year. Washington.	Madison.	Lincoln.
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
July 30	486	460	.....	+ 12	−16	.....	+ 635	−4,341	.....
Aug. 6	491	466	.....	+ 31	+ 6	.....	+ 852	−4,298	.....
Aug. 13	440	492	.....	− 1	+47	.....	+ 848	−3,966	.....
Aug. 20	543	439	.....	+123	+14	.....	+1,706	−3,870	.....
Aug. 27	467	406	.....	+ 60	+ 2	.....	+2,128	−3,855	.....

MEASUREMENTS OF THE SOLAR CONSTANT OF RADIATION AT CALAMA, CHILE, JUNE AND JULY, 1921.

By C. G. ABBOT, Assistant Secretary.

[Smithsonian Institution, Washington, Sept. 29, 1921.]

In continuation of preceding publications, I give in the following table the results obtained at Montezuma, near Calama, Chile, in June and July, 1921, for the solar constant of radiation. The reader is referred to this REVIEW for February, August and September, 1919, for statements of the arrangement and meaning of the table.

It will be noted that in contrast to the June and early July values the observations reported from July 9 to

July 25, inclusive, are almost invariably unusually high. As no results were reported between July 3 and July 9, it does not appear when this period of high values actually commenced. These facts are noted because the writer has been repeatedly asked by interested parties whether there was anything in the solar constant values of the past summer corresponding to the march of temperatures observed in the United States.

Date.	Solar constant.	Method.	Grade.	Transmission coefficient at 0.5 micron.	Humidity.			Remarks.
					$\rho/\rho sc$	V. P.	Rel. hum.	
1921.								
P. M.	*cal.*					*cm.*	*Per cent.*	
June 4	1.945	$M_{1.40}$	S	0.886	0.816	0.11	7	
	1.942	$M_{1.92}$						
	1.943	W. M.						
7	1.914	$M_{3.08}$	S—	.889	.877	.11	5	
8	1.938	$M_{2.19}$	S	.886	.828	.06	2	Thin cirri all morning.
	1.938	$M_{1.96}$						
	1.938	W. M.						
A. M.								
9	1.967	E_0	VG	.875	.758	.04	4	
	1.928	M_2						
	1.914	$M_{2.5}$						
	1.932	M_2						
	1.951	$M_{1.5}$						
	1.938	W. M.						
P. M.								
11	1.927	$M_{2.18}$	S	.880	.590	.20	8	Cumuli over high peaks.
	1.931	$M_{1.98}$						
	1.929	W. M.						
13	1.937	M_3	S—	.883	.634	.20	12	Cirri in east and low in west
18	1.951	$M_{1.65}$	S—	.883	.778	.18	13	Some cirri in north and east.
	1.949	$M_{1.87}$						
	1.950	W. M.						
A. M.								
19	1.930	M_3	S	.881	.585	.24	29	Clouds over high peaks.
	1.929	$M_{2.5}$						
	1.929	W. M.						
P. M.								
20	1.933	M_3	S—	.883	.579	.21	14	
21	1.942	$M_{1.74}$	S—	.882	.649	.23	11	Cirri scattered about sky.
22	1.948	$M_{1.63}$	S—	.880	.642	.28	15	Heavy cirri in north and east.
	1.960	$M_{1.63}$						
	1.955	W. M.						
24	1.930	M_3	S—	.883	.607	.20	13	
	1.950	$M_{2.5}$						
	1.943	W. M.						
25	1.938	M_2	S	.880	.614	.22	17	Little cirri over high peaks.
	1.941	$M_{1.72}$						
	1.940	W. M.						
A. M.								
26	1.949	M_2	S	.886	.809	.13	10	
	1.935	$M_{2.30}$						
	1.941	W. M.						
P. M.								
27	1.950	M_3	S—	.885	.746	.11	6	
	1.933	$M_{2.61}$						
	1.940	W. M.						
28	1.946	M_3	S	.885	.739	.09	5	Thin cirrus in morning.
	1.946	$M_{2.5}$						
	1.938	M_2						
	1.944	W. M.						
A. M.								
29	1.950	$M_{1.5}$	S	.885	.803	.10	6	
	1.955	$M_{1.47}$						
	1.952	W. M.						

Date.	Solar constant.	Method.	Grade.	Transmission coefficient at 0.5 micron.	Humidity.			Remarks.
					$\rho/\rho sc$	V. P.	Rel. hum.	
1921.								
P. M.	*cal.*					*cm.*	*Per cent.*	
July 1	1.935	M_3	S—	0.885	0.781	0.07	4	Thin cirri in morning.
	1.937	$M_{2.5}$						
	1.948	$M_{2.08}$						
	1.939	W. M.						
2	1.943	$M_{2.5}$	S	.886	.770	.07	4	Heavy cirri low in north, east, and west.
	1.941	M_2						
	1.955	$M_{1.5}$						
	1.946	W. M.						
A. M.								
3	1.944	$M_{1.95}$	S—	.886	.824	.05	4	Cirri in north and east.
	1.953	$M_{1.81}$						
	1.947	W. M.						
P. M.								
9	1.960	$M_{1.5}$	S	.886	.872	.11	5	
	1.958	$M_{1.43}$						
	1.959	W. M.						
10	1.966	M_3	S	.885	.785	.15	7	Thin cirri in morning.
	1.955	$M_{1.5}$						
	1.969	$M_{1.84}$						
	1.964	W. M.						
A. M.								
11	1.930	M_3	S—	.883	.727	.08	7	Little cirri in south, and forming in north and west during last observation.
	1.927	$M_{2.5}$						
	1.954	M_2						
	1.936	W. M.						
13	1.951	$M_{1.40}$	S	.878	.735	.52	9	
	1.951	$M_{1.40}$						
	1.951	W. M.						
P. M.								
14	1.955	$M_{1.5}$	S	.882	.758	.18	9	
	1.952	$M_{1.61}$						
	1.956	$M_{1.44}$						
	1.954	W. M.						
A. M.								
15	2.017	E_0	E—	.869	.427	.18	18	Heavy cumulus in east, and some in north and west.
P. M.								
20	1.946	$M_{1.5}$	S—	.884	.774	.16	10	Thick cumulus in north and east.
	1.957	$M_{1.75}$						
	1.952	W. M.						
A. M.								
21	1.952	$M_{1.37}$	S	.885	.779	.15	7	
	1.964	$M_{1.28}$						
	1.961	$M_{1.42}$						
	1.959	W. M.						
22	1.946	$M_{1.5}$	S	.884	.773	.10	5	
	1.955	$M_{1.47}$						
	1.950	$M_{1.48}$						
	1.951	W. M.						
25	1.951	$M_{1.5}$	S	.886	.819	.27	11	
	1.951	$M_{1.90}$						
	1.951	W. M.						
26	1.924	$M_{1.5}$	S	.884	.677	.32	14	Clouds in west and east.
	1.925	$M_{1.42}$						
	1.925	$M_{1.37}$						
	1.925	W. M.						
27	1.912	$M_{1.47}$	S—	.872	.643	.22	9	
	1.923	$M_{1.80}$						
	1.921	W. M.						
28	1.955	$M_{1.40}$	S—	.880	.733	.18	8	
P. M.								
29	1.941	$M_{1.74}$	S	.884	.778	.32	13	Cumuli over high peaks.
	1.958	$M_{1.92}$						
	1.949	W. M.						Some cirri in south.
A. M.								
31	1.938	$M_{1.88}$	VG	.877	.675	.33	23	Some cirri over high peaks.
	1.820	$M_{1.62}$						
	1.938	W. M.						

WEATHER IN NORTH AMERICA AND ADJACENT OCEANS.

NORTH ATLANTIC OCEAN.

By F. A. YOUNG.

The average pressure for the month was nearly normal or slightly above at land stations on the American and greater part of the European coast, as well as in the West Indies, the Bermudas, and Azores, while it was somewhat lower than usual at stations on the east coast of England.

The number of days on which fog was reported was apparently below the normal over the Banks of Newfoundland and along the steamer lanes, while it was more frequent than usual off the north coast of Scotland.

The number of days with winds of gale force was not far from the normal as shown on the Pilot Chart, and they did not occur on more than two days in any 5° square.

On the 1st there was a LOW in the vicinity of Nova Scotia; it moved slowly eastward and on the 3d was central near latitude 53 N., longitude 42 W. This disturbance was of limited extent and not especially severe, although a few vessels experienced winds of gale force, as shown by following storm logs and special report.

American S. S. *Texarkana:*

Gale began on the 1st, wind SW. Lowest barometer 29.92 inches at 8 a. m. on the 2d, wind SW; position, latitude 41° 42′ N., longitude 47° 45′ W. End of gale at noon on the 2d, wind SW. Highest force of wind 8, SW.; steady from SW.

American S. S. *Dochet:*

Gale began on the 2d, wind S., 6. Lowest barometer 29.70 inches at 4 a. m. on the 3d, wind WSW., 6; position, latitude 47° 40′ N., longitude 38° 30′ W. End of gale on the 4th, wind NW. Highest force of wind 8, W.; shifts WSW.–W.

British S. S. *Bellena:*

On the 3d and 4th in latitude 38° 58′ N., longitude 52° W., ran into a fresh gale which commenced about 8 p. m. on the 3d, with the wind SW., increasing rapidly and barometer falling rapidly from 30.11 inches at noon to 29.92 inches at 8 p. m.; sea rough and weather squally. At 11 p. m. wind shifted to NW. by W. in heavy rain squall and increased to hard gale, force 8; sea becoming very high and confused. It continued to blow fresh gale with force 7 to 8 until 1:30 a. m. on the 4th, with the barometer at 29.86 inches at midnight. At 1 a. m. barometer began to rise slowly and at 1:30 the wind moderated rapidly, with decreasing sea. At 8 a. m. the wind was force 3 and had backed to south; by noon it had increased to force 5, barometer 29.92 inches. At 9:40 p. m. wind veered to NE., moderating rapidly; weather fine with rising barometer.

The movement of this LOW from the 3d to the 4th was slight, and on the latter date there was but little change in the barometer readings near the center, where light to moderate winds prevailed. On the 5th there was a slight disturbance off the south coast of Ireland, as shown by the storm log from the American S. S. *Assinippi:*

Gale began on the 5th, wind SSW. Lowest barometer 29.76 inches at 3 a. m. on the 5th, wind SSW., 8; position, latitude 49° 12′ N., longitude 12° 07′ W. End of gale on the 5th, wind W. Highest force 8, SSW.; steady from SSW.

At Greenwich mean noon on the 5th there was a LOW central near the 40th parallel and 50th meridian; at that time moderate winds prevailed, although the American S. S. *Clifford*, while in that vicinity, encountered a gale of hurricane force in the afternoon of the 5th, as shown in the following report:

Disturbance came during heavy downpour of rain. Wind blew from every point of the compass, forming a circle that blew water to the center. Clouds and sea shifted with wind. Cyclonic winds lasted about 20 minutes, followed by a downpour of rain. Moderate variable winds for 30 minutes, then steady from the NE. at 7 p. m., increasing to fresh gale; barometer rapidly rising. At 11 p. m. wind suddenly decreased to moderate breeze. Lowest barometer 29.73 inches at 4 p. m., wind NE., 8. Highest force 12.

This LOW remained practically stationary during the next 24 hours, and on the 6th moderate winds were the rule, as only the British S. S. *Ventura de Larringa* reported heavy weather, as shown by the following storm log:

Gale began on the 4th, wind WSW. Lowest barometer 29.80 inches at 6 a. m. on the 6th; position, latitude 36° 05′ N., longitude 50° 25′ W. End of gale on the 6th, wind ENE. Highest force 8, N.; shifts SSW.–W.–NE.–N.

From the 7th to the 14th there were no disturbances of any consequence, and during the latter part of this period the Azores HIGH was unusually well developed.

On the 15th there was a slight depression over Nova Scotia and moderate northwesterly gales were encountered between the 35th and 42d parallels and the 63d and 66th meridians. Report from the Belgian S. S. *Eglantier* follows:

From 12 to 4 a. m. on the 15th lightning on the horizon, between WSW. and WNW. At 7 a. m. heavy squalls from the SW.; force of wind from 6 to 9. Began to moderate at noon.

On the same day there was a second LOW central about 400 miles west of the Irish coast. At Greenwich mean noon on the 15th only light to moderate winds were reported, although the American S. S. *Eastern Belle* ran into a gale later in the day as shown by her storm log:

Gale began on the 15th, wind WNW. Lowest barometer 29.60 inches at 6 p. m. on the 15th, wind WSW, 8; position, latitude 52° 05′ N., longitude 19° 55′ W. End of gale on the 16th, wind NW. Highest force 8, NW; shifts SSW–NW.

This disturbance moved but little during the next 24 hours; by the 16th it had increased somewhat in intensity, and the storm area in extent. Storm logs follow:

American S. S. *Jackson:*

Gale began on the 15th, wind WNW. Lowest barometer 29.88 inches at 4 a. m. on the 16th, wind W, 8; position, latitude 49° 38′ N., longitude 19° 45′ W. End of gale on the 16th, wind NW. Highest force 8, W; shift 2 points.

American S. S. *Worcester:*

Gale began on the 15th, wind SW. Lowest barometer 29.77 inches at 4.35 a. m. on the 16th, wind SSW, 8; position, latitude 53° 02′ N., longitude 40° 48′ W. End of gale on the 17th, wind SSW. Highest force 8, SSW; steady from SW.

On the 17th there was an area of low pressure over the southern part of the British Isles and a limited region between the 45th and 50th parallels and the 15th and 20th meridians was swept by moderate northerly to northwesterly gales.

At Greenwich mean noon on the 18th and 19th moderate weather prevailed over practically the entire ocean, although in the period between these hours the American S. S. *Volunteer* encountered a southwesterly gale, as shown by following storm log:

Gale began on the 19th, wind S. Lowest barometer 29.74 inches at 2 a. m. on the 19th, wind S; position, latitude 41° 40′ N., longitude 62° 55′ W. End of gale on the 19th, winds WSW. Highest force 9; steady from WSW.

From the 20th to the 25th there was another period of inactivity, with high pressure and slight barometric gradients over the greater part of the ocean, although shortly after Greenwich mean noon on the 24th the Belgian S. S. *Nervier* ran into a southerly gale about 300 miles south of St. Johns, Newfoundland. Storm log follows:

Gale began on the 24th, wind SSW. Lowest barometer 29.84 inches at 8 p. m. on the 24th, wind SSW, 9; position, latitude 43° 20′ N., longitude 53° 03′ W. End of gale on the 25th. Highest force of wind 10, SSW; shifts SSW–W–N.

On the 25th and 26th quiet weather prevailed over all the ocean except for a disturbance of limited extent off the Irish Coast.

Charts IX, X, XI, and XII show the conditions on the 28th, 29th, 30th, and 31st, respectively, when there was a slow moving and well defined LOW over the eastern section of the steamer lanes.

The U. S. Shipping Board steamer *Ingold*, Captain Morgan, cleared from Glasgow for Norfolk on the 24th. She encountered unusually stormy weather for a period extending well into September, as shown by a very comprehensive report submitted by Mr. R. A. A. Ostrom, second officer:

The heavy weather began at midnight on the 25th, wind NW.; force 8, barometer 29.97 inches. At noon on the 26th, position, latitude 55° 27′ N., longitude 9° 32′ W., the wind shifted to SW., 8, and then increased in velocity, as at 4 p. m. the direction and force were W., 12; barometer 29.61 inches.; 8 p. m. SW., 12; 29.58 inches. Midnight NW., 12; 29.71 inches; 4 a. m., on the 27th, SW., 12; 29.74 inches. Position at noon on the 27th, latitude 55° 06′ N., longitude 12° 48′ W. From 8 a. m. on the 27th until 8 a. m. on the 29th the wind direction varied from WNW. to WSW., the force from 5 to 9, and the barometric readings from 29.75 inches to 29.93 inches. At 9 a. m. on the 29th a shift of 180 degrees from west to east occurred. The wind then began to veer, increasing slowly in force, and at 10 a. m. on the 30th the direction was SE., 9; barometer 29.51 inches. There was another shift at 11 a. m., when the lowest barometric reading of 29.47 inches occurred, and at 2 p. m. the direction and force were NW., 10; barometer, 29.52 inches. These conditions remained fairly constant until 5 a. m. on the 31st, when the weather began to moderate and the barometer had risen to 29.88 inches. The noon positions of the vessel are as follows: 29th, latitude, 49° 53′ N., longitude 20° 50′ W; 30th, latitude 48° 57′ N., longitude 25° 30′ W; 31st, latitude 46° 51′ N., longitude 29° 44′ W.

The *Ingold* also had the unique experience of being badly shaken up by a waterspout, as Mr. Ostrom reports that at about 8 a. m. on the 30th a terrific gust of wind struck the vessel, being violent enough to hurl the man at the wheel 15 feet and swing the ship around. Immediately afterward a waterspout was sighted off the starboard bow.

Vessel storm logs follow:

Belgian S. S. *Londonier:*

Gale began on the 28th, wind E. Lowest barometer 29.34 inches at 2 p. m. on the 28th, wind NNE.; position, latitude 47° 38′ N., longitude 37° 47′ W. End on the 29th, wind NNE. Highest force 12, ENE.; shifts not given.

British S. S. *Zeeland:*

Gale began on the 28th, wind SW. Lowest barometer 29.28 inches at 11:20 p. m. on the 29th, wind SW.; position, latitude 47° 20′ N., longitude 29° 31′ W. End on the 30th, wind NW. Highest force 10; shifts SW.–W.–NW.

British S. S. *Glensloy:*

Gale began on the 30th, wind SE. Lowest barometer 29.35 inches at 4 p. m. on the 30th, wind SE.; position, latitude 50° 30′ N., longitude 21° 50′ W. End on the 31st, wind SW. Highest force 11; shifts S–SSW.

NORTH PACIFIC OCEAN.

By F. G. TINGLEY.

Pressure was below normal at Dutch Harbor during the first decade of the month, the departure for this period being approximately −0.28 inch. The lowest barometer reading, 29.20 inches, was recorded on the 3d. During the second and third decades pressure was generally above normal, with the highest reading 30.28 inches, recorded on the 31st.

At Midway Island pressure was above normal by some 0.05 inch during the first and second decades and below normal by 0.10 inch during the last decade. Departures at Honolulu were similar to those at Midway Island, but the amounts were smaller.

Over the central and eastern portions of the ocean August was a very quiet month. In these waters but three vessels experienced winds of gale force. The Japanese S. S. *Tokushima Maru*, Capt. S. Shibutami, Yokohama for Vancouver, had moderate S. to SW. gales on the 3d and 4th when in latitude 51°–50° N., longitude 141°–135° W. The Danish M. S. *Indien*, Capt. H. Jacobsen, observer, H. V. Lingaae, San Diego for Panama, had gales on the 17th and 18th, reports of which are as follows:

Gale began on the 17th; lowest barometer 29.63 inches at 4 a. m. of the 18th in latitude 19° 39′ N., longitude 106° W.; wind at that hour ESE., force 9, with heavy NW. sea; end of gale on 18th; shifts of wind, SE., ESE., E., ESE.; highest force, 9, ESE.

Gale began on the 20th; lowest barometer 29.68 inches at 2 a. m. of the 21st; wind N. by E., force 8, with heavy sea from S.; end of gale on 21st; shifts of wind, ENE., NNE., N.; highest force, 8, N. by E.

The Chinese S. S. *Hwah Ding*, Capt. J. Thorvig, observer, M. Blaise, Honolulu for Panama, experienced a moderate to fresh SE. gale with a heavy sea on the 30th, when in latitude 17° 52′ N., longitude 116° W.

In Asiatic waters the most important feature of the weather of the month was the typhoon of the 14th–21st. This typhoon appears to have formed in the region between the Bonin Islands and Guam and was first noted on the 14th. Warnings regarding it were broadcast from various radio stations during the period from the 14th to the 19th. Capt. C. Ericksen, of the American S. S. *West Cayote*, Portland for Moji, has furnished the following report of those received aboard his vessel:

Date August, 1921.	Time.	Latitude N.	Longitude E.	Barometer at center.	Direction.	Radio station.
		°	°	*Inches.*		
14	6 a. m.	22	142	29.13	wnw.	Otchisshi.
14	12 noon	23	142	28.98	wnw.	Funabashi.
15	6 a. m.	25	142	28.50	nnw.	Otchishi.
15	12 noon	27	141	28.25	nw.	Choshi.
16	6 a. m.	29	138	28.50	nw.	Do.
16	12 noon	29	136	28.50	wnw.	Otchishi.
16	6 p. m.	29	134	28.74	wnw.	Do.
17	6 a. m.	29	132	28.74	w.	Do.
17	12 noon	29	131	28.74	w.	Choshi.
17	6 p. m.	30	131	28.74	w.	Dairenwan.
18	6 a. m.	30	130	28.74	wnw.	Maizuru.
18	12 noon	30	129	28.74	w.	Do.
19	6 a. m.	29	128	28.58	w.	Tsunoshimi.
19	12 noon	29	127	28.60	w.	Shimotsui.
19	6 p. m.	29	127	29.06	w.	Dairenwan.

Capt. Ericksen states that the reports were plotted on a chart and the movements of the typhoon carefully followed.

This typhoon followed an altogether unusual track, as will be seen by comparing the position from day to day, as given above, with the tracks for August typhoons shown in the MONTHLY WEATHER REVIEW for February, 1921.[1]

According to press dispatches the typhoon appears to have passed inland on the China coast a short distance to the south of Shanghai some time prior to the 23d. The following account of the losses caused is taken from the *New York Sun* of August 24, 1921:

Shanghai, China, August 23.—Fears that a death list running as high as 10,000 has resulted from typhoons around Kingpo on the coast and on the Yangste River were expressed by relief workers to-day.

All communication with the district has been severed.

Two European steamers were reported driven aground on the Shanghai bar and several hundred junks were swamped.

Several vessels were more or less involved in this typhoon and have furnished reports of conditions experienced as follows:

Japanese S. S. *Taiyo Maru*, Capt. S. Togo, observer, M. Nitta, Hongkong for San Francisco.

Gale began on the 18th; lowest barometer 29.26 inches at 3 a. m. of the 19th, in latitude 32° 12′ N., longitude 127 E.; wind at that hour, NE. by N., force 10, with a high NNE., sea; gale ended on 19th; highest force of wind, 11, NE. by N.

[1] Reproduction of August Charts from Atlas of the Tracks of 620 Typhoons, 1893–1918, by Louis Froc, S. J.

American S. S. *China*, Capt. F. W. Wise, observer, V. D. Forbes, Singapore for San Francisco.

Gale began on the 15th; lowest barometer, 29.41 inches at 4 p. m. of the 16th, in latitude 32° 40′ N., longitude 133° 35′ E.; wind at that hour, NNE., force 10; shifts of wind, ENE., NE., E.; highest force 10, NNE.

The *China* previously had experienced a fresh gale, on the 13th–14th, when in latitude 31° 30′ N., longitude 123° 30′ E., at which time the barometer fell to 29.51 inches.

American S. S. *West Kader*, Capt. Ludwig Petting, observer, C. E. Johnson, Shanghai for Kobe.

Gale began on the 17th; lowest barometer, 28.68 inches at 4.30 p. m. of the 19th, in latitude 30° 48′ N., longitude 127° 28′ E.; wind at that hour NE., force 8; end of gale on 20th; shifts of wind, NE., SE.; highest force, 12, ESE. During the height of the storm the *West Kader* was hove to, stern to sea.

As was the case in July, a large amount of fog was reported by vessels on the northern steamship routes.

GALES IN THE SOUTH PACIFIC OCEAN.

Several vessels on routes between North American and Australian ports experienced gales in the South Pacific Ocean at the end of July and the beginning of August. The British R. M. S. *Tahiti*, Capt. A. M. Edwin, observer, J. W. Murray, Sydney for San Francisco, via Wellington, ran into heavy weather on leaving the first-named port on July 28 and also on leaving Wellington on August 3. Low pressure prevailed over the Tasman Sea between the dates named, the lowest reading recorded being 28.97 inches. The British R. M. S. *Niagara*, Capt. J. T. Rollo, observer, P. W. B. Denniston, Honolulu for Sydney, was involved in the same general storm from July 31 to August 3. The American S. S. *Ventura*, observer, C. S. Vickery, Sydney for San Francisco, felt the last of the gale on leaving port on the 3d. Reports are as follows:

R. S. M. *Tahiti*.

Gale began on July 28; lowest barometer 29.71 inches at noon of that date off Sydney Heads; wind then SSW., force 10, with very rough sea; end of gale on 29th; wind steady from SSW.; highest force, 10.

Gale began in early morning of 3d and ended at noon of same date; lowest barometer, 29.02 inches, occurred at 12.30 a. m. in latitude 38° 03′ S., longitude 178° 50′ E.; wind steady from NW., highest force, 9; high sea.

R. S. M. *Niagara*.

Gale began on July 31; lowest barometer 29.10 inches at 8 p. m. same date in latitude 34° 17′ S., longitude 162° 56′ E.; wind at that hour W. by N., force 8, high sea; moderate gale still blowing on arrival at Sydney at 11.30 a. m. August 3; shifts of wind, W. by N. to SW.

S. S. *Ventura*.

Gale began on 3d; lowest barometer 29.27 inches at noon, same date, in latitude 33° 50′ S., longitude 151° 18′ E.; wind at that time, W. by N., force 9; heavy following sea and swell; gale ended on 4th; shifts of wind, W. by N. to WSW.; highest force, 9, W. by N.

CRUISE OF U. S. S. BEAR IN ARCTIC OCEAN.

During the month of August, 1921, the U. S. Coast Guard cutter *Bear* made a cruise in the Arctic Ocean, proceeding along the north coast of Alaska as far east as the Canadian boundary, longitude 141° W. Lieut. Commander C. S. Cochran, commanding the *Bear*, and Lieut. R. T. McElligott, acting as meteorological observer, have furnished the Weather Bureau with a report of the weather experienced during the voyage.

The *Bear* passed Cape Lisburne northward bound on the 3d and reached the end of the outward voyage on the 16th. Returning, Bering Strait was passed on the 27th. Between the 3d and 16th the wind was almost constantly from the ENE., the force generally varying from 3 to 6, Beaufort. The temperature of the air, as observed at Greenwich mean noon, or from about 1 a. m. to 2.30 a. m., according to the position of the vessel, ranged from 50° to 30° F. The average temperature for the period between the 3d and 9th was 42° and for that between the 10th and 16th, 35°. For the corresponding periods the temperatures of the surface water were 45° and 32°, respectively.

Between the 18th and 21st the wind was westerly, mostly WSW., force 1 to 5; average air temperature, 41°, water temperature, 42°. On the 22d the wind turned to ENE. and on the 23d to E., remaining then between E. and S. until the 27th and varying in force from 2 to 6. The air temperature from the 22d to the 17th averaged 50°, water temperature, 54°.

Lieut. McElligott states that in general the weather during the cruise was foggy, misty, and hazy. There was not a day without its period of fog or mist. Generally the fog lifted after noon, then holding on and off until night. At Point Barrow it swept across the point in waves. East of there the fog was heavy, lifting as a rule in the morning, settling again in the late afternoon or evening. The last three days of the voyage were marked by several hours of rain and many showers. On the 31st, when approaching St. Michaels, the day broke bright and clear, with fracto-cumulus clouds all around the horizon.

NOTES ON WEATHER IN OTHER PARTS OF THE WORLD.

British Isles.—Conditions were unsettled throughout the month, with depressions from the Atlantic crossing the British Isles. In the north and west the rainfall was large, but in the southeast of England, it was again below normal, being much less than might have been expected from the distribution of pressure.[1]

France.—At the beginning of the month the drought was continuing in France with undiminished severity. Forest fires and the destruction of mills and farms were being reported daily, the largest being that of the forest of Vorey-sur-Azon, which at one time threatened the towns of Vorey and Bellevu. Heavy rain fell later in southern France, and severe floods on the Garonne and its tributaries. Snow fell in Savoy on the 15th.[1]

Switzerland.—Heavy rain has fallen in many parts of Switzerland, breaking the prolonged drought.[1]

Norway.—Spitzbergen, August 6.—The heat wave has at last struck Lapland and the polar regions. With the thermometer at 86 degrees, the Eskimos have thrown away their fur garments and are organizing bathing parties. For most Eskimos this bath will be the event of a lifetime, perhaps never to be repeated. The game and reindeers are suffering intensely.—*New York Evening Post, August 7, 1921.*

China.—Peking, August 25.—Hundreds of villages have been destroyed and thousands of persons left homeless by an overflow of the Hoang-ho, or Yellow River, which, after a month of heavy rainfall, has flooded large areas of the province of Shantung. * * * There has been widespread destruction of crops over the districts of Shantung which, during the last spring and summer, have been suffering from famine.—*New York Tribune, August 26, 1921.*

Australia.—Melbourne, August 4.—Recent heavy weather, accompanied by considerable snowfall and heavy rain, in the State of Victoria, Australia, is causing considerable anxiety in shipping circles there. Even in Melbourne, where such conditions are most unusual, several ocean vessels are overdue and there is concern about coastwise traffic.—*New York Journal of Commerce, August 5, 1921.*

The gales and floods in eastern Australia in July were followed in New South Wales and Victoria by the coldest weather experienced for a quarter of a century. Snow has fallen in districts where it has never been seen before.[1]

[1] *Meteorological Magazine*, September, 1921, pp. 232-240.

[1] *Meteorological Magazine*, September, 1921, pp. 232-240.

DETAILS OF THE WEATHER OF THE MONTH IN THE UNITED STATES.

GENERAL CONDITIONS.

By A. J. HENRY.

The outstanding feature of the month was some abatement of the heat which had prevailed almost continuously during the two months immediately preceding. Droughty conditions of the previous month appeared to have drifted to the eastward being most pronounced in Atlantic coast States, including Florida and the Gulf States, whereas the Ohio and middle Mississippi valleys had generous rains.

As compared with the previous month, pressure rose, especially in the Gulf and Atlantic Coast States, thus augmenting in a measure the high pressure in Southern districts which has featured the weather of some months past.

CYCLONES AND ANTICYCLONES.

By W. P. DAY, Observer.

Migratory low-pressure areas charted during the month considerably exceeded the average, but were in no case important as storms.

High-pressure areas were typical. The budding off from the North Pacific HIGH became less frequent and migratory HIGHS began to make their appearance from the regions north of Alberta.

Tables showing the number of HIGHS and LOWS by types follow:

LOWS.	Alberta.	North Pacific.	South Pacific.	Northern Rocky Mountain.	Colorado.	Texas.	East Gulf.	South Atlantic.	Central.	Total.
August, 1921	7.0	1.0	.....	.....	2.0	.....	.....	.....	5.0	15.0
Average number, 1892-1912, inclusive	4.2	0.6	0.3	0.9	1.0	0.2	(1)	0.1	1.0	8.3

[1] Only one occurrence.

HIGHS.	North Pacific.	South Pacific.	Alberta.	Plateau and Rocky Mountain Region.	Hudson Bay.	Total.
August, 1921	2.0	.....	3.0	1.0	2.0	8.0
Average number, 1892-1912, inclusive	1.8	0.2	3.0	0.9	0.8	6.7

THE WEATHER ELEMENTS.

By P. C. DAY, Climatologist and Chief of Division.

PRESSURE AND WINDS.

August, 1921, like the preceding month, was relatively free from important pressure changes, and both cyclonic and anticyclonic areas were poorly defined and showed the usual uncertain movements common to the summer atmospheric circulation. A number of low areas appeared over the middle and southern Plateau regions and crossed the Rocky Mountains in a northeasterly direction and moved eastward along the northern border, but usually without material energy until reaching the Canadian Maritime Provinces, where they developed into storms of some importance. The high-pressure areas were somewhat better defined than the LOWS. The most important moved eastward along the northern border during the first half of the third decade, modifying materially the weather over eastern districts during that period.

Pressure for the month, as a whole, was above normal in practically all portions of the United States and Canada, the only material exception being a small area in the northern Rocky Mountains.

Pressure was highest over the southeastern States, diminishing northward and westward. As a result the air movement over the districts east of the Rocky Mountains was mostly from southerly points. This was the case also over portions of the Rocky Mountain and Plateau districts. Over the Pacific Coast States the winds were mostly from the north or northwest.

High winds were confined usually to local small areas, mostly in connection with thunderstorms, but these were widely scattered and on the whole fewer than is usually expected during the last summer month. Details of the more important wind and other storms appear at the end of this section.

TEMPERATURE.

Moderate conditions as to temperature were marked features of the weather during the month. Periods of severe heat were usually of short duration and changes from day to day were of small proportions.

The warmest periods showed much divergency as to time of occurrence in the different portions of the country, ranging from the first day of the month in portions of the East Gulf States, to the last day or two along the northern border from Montana eastward.

Maximum temperatures of 100° or higher were observed in some portions of all the States except in the Lake region and North Atlantic States, where they were a few degrees less. In the middle and southern Great Plains maximum temperatures of 110° were observed locally, and they were 115° and 118°, respectively, at points in Arizona and southern California.

The dates of lowest temperatures were likewise well distributed during the month, ranging from the 3d in New England to the 28th and 29th in portions of the Gulf States and Plateau region. The most extensive cool period occurred from the 5th to 8th, and covered much of the country from the Great Plains southeastward to the Middle Gulf States. The lowest temperature reported, 19°, occurred in the mountains of Colorado, and temperatures below 32° were reported from many of the higher elevations from the Rocky Mountains westward, and at a few points along the northern border from the upper Lakes to Montana.

For the month as a whole the average temperature was again above normal over large portions of the country, though the departures were relatively small. A marked feature of the monthly mean temperatures was the further continuation of the already remarkable period, with monthly means above normal, which has been a persistent factor in the weather of the north-central part of the country for the past 12 months.

Beginning with September, 1920, and for each month since that time, the average temperature has been above normal over the greater part of the area referred to above, and the amounts of these departures have been so great that the average excess for the entire period at some points is more than 5° per day, an accumulation of heat that has not been closely approached in a period of more than 50 years.

PRECIPITATION.

The earlier portion of the month had very general and substantial rains over the greater part of the country from the Rocky Mountains eastward, although over small areas the amounts were insufficient to relieve the drought conditions that had persisted during much of the preceding month.

During the latter half of the month precipitation was very generally deficient over the eastern half of the country, particularly over the Gulf and Atlantic coast States, where drought conditions had become serious by the end of the month.

In the far West precipitation was unusually frequent and in generous quantity over the southern Rocky Mountain and Plateau regions, particularly in Arizona, where numerous local floods were caused by the heavy run-off. In Colorado the average precipitation for the State was the greatest for August of record, and in Arizona only one preceding August in the past 25 years had a greater average. In other portions of the far West precipitation was light as usual for August.

For the month as a whole precipitation was less than usually received over the Atlantic and Gulf States from New England to Texas, the deficiency being of serious proportions in the South Atlantic States as a whole, and in local areas of the other States. There was a considerable deficiency in Oklahoma, and portions of the Northwest likewise had considerably less rain than is usually received. On the other hand, the Ohio and Mississippi Valley States had frequent and in some cases heavy rains, and the monthly totals were well above the normal amounts, and similar conditions prevailed in Arizona, New Mexico, Colorado, Utah, and portions of the adjoining States.

In all portions of the country there were large variations in the total falls at comparatively near-by points, notably in the South and middle West where amounts ranged locally from less than 1 to more than 10 inches.

RELATIVE HUMIDITY.

In the main the atmospheric moisture as indicated by the relative humidity conformed to the precipitation conditions, the averages being less than normal in the regions of deficient precipitation, and greater where precipitation was in excess. As a rule the departures from the normal were not excessive, although in portions of the Southwest there were large variations both above and below the normal.

SEVERE LOCAL STORMS.

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau.]

Place.	Date.	Time.	Width of path.	Loss of life.	Value of property destroyed.	Character of storm.	Remarks.	Authority.
			Yards.					
Brazil, Ind.	2	P. m.				Electrical and rain.	Damage to buildings and electric wires.	Tribune (Terre Haute, Ind.).
Winfield, Kans., and vicinity.	4	P. m.				Hail.	Automobile tops, street lamps, skylights, and greenhouses demolished.	Times (Kansas City, Mo.).
Independence, Kans.	4	P. m.				Wind.	Severe damage suffered by buildings, crops, and telephone lines.	Do.
Fredonia, Kans.	4	P. m.				Wind and hail.	Buildings, crops, and trees damaged; poultry killed.	Wichita Eagle (Wichita, Kans.).
El Dorado, Kans., and north Butler County.	5	P. m.				Wind.	Heavy losses to gas and oil companies.	Do.
Port Huron, Mich. (north of).	6				$25,000	Hail.		Official U. S. Weather Bureau.
Kansas City, Mo.	6	4.30 a. m.				Wind, rain, and electrical.	Considerable damage; heaviest losses sustained by telephone and electric light companies.	Star (Kansas City, Mo.).
Lawrence, Kans.	6					Rain.	5.30 inches of rain; cellars flooded.	Do.
Cleveland, Ohio.	6	P. m.		1		Electrical, wind, and rain.	Streets and cellars flooded; wires down; heavy property losses.	Plain Dealer (Cleveland, Ohio).
Denton, Tex.	7	P. m.			25,000	Electrical.	$25,000 damage from fires by lightning.	Dallas Morning News (Dallas, Tex.)
Annapolis, Md.	7					Wind.	Air-marine seaplane wrecked.	Washington (D. C.) Herald.
New York City and vicinity.	7	P. m.		2		Thunderstorm.	Many persons injured by lightning.	Brooklyn Daily Eagle.
Aberdeen, S. Dak.	9					Wind.	General damage done; two persons injured.	The Courier News (Fargo, N. Dak.)
Egeland, N. Dak.	10		5,280			Hail and wind.	High winds move barns and granaries and demolish small buildings.	The Fargo Forum (Fargo, N. Dak.)
Charleston, S. C.	10	A. m.			1,200	Small tornado.	Damage slight.	Official U. S. Weather Bureau.
Sedalia, Mo.	10	P. m.		1	10,000	Wind and rain.	Considerable property damage done.	Star (Kansas City, Mo.).
Topeka, Kans., and vicinity.	10	P. m.				Rain.	Aside from flooded basements, little damage was done.	Do.
Southern Wisconsin and northern Illinois.	19	P. m.				Wind and rain.	A severe wind and rain storm of wide extent swept over southern Wisconsin and northern Illinois, causing extensive property and public utilities losses; crops and live stock suffered severely and a number of people were killed; the loss is estimated at $1,000,000 or more.	Press (Sheboygan, Wis.); Official U. S. Weather Bureau; Times Journal (Dubuque, Iowa); Evening News (Kenosha, Wis.); Journal (Chicago, Ill.).
Phoenix, Ariz., northwest of.	19	P. m.		1	200,000	do.	Buildings destroyed; wires down; streets flooded.	Arizona Republican (Phoenix, Ariz.).
Phoenix, Ariz. (near).	21				240,000	Rain.	A heavy rain over the Cave Creek watershed, near Phoenix, resulted in a flood of serious proportions in Phoenix.	Official U. S. Weather Bureau.
Fargo, N. Dak., and vicinity.	25	P. m.				Cloudburst	Considerable damage caused by rain.	Courier News (Fargo, N. Dak.).
Elizabethtown, Tenn.	25						Serious injury to crops over small area; chickens and birds killed.	Official U. S. Weather Bureau.
Denton, Tex.	26					Cloudburst and wind.	Slight damage to buildings.	Dallas Morning News (Dallas, Tex.).
Corsicana, Tex.	26					Rain.	Cotton slightly damaged.	Do.
Luling, Tex.	26					Wind and rain.	Slight general damage.	Do.
Green Bay, Wis.	26					Thunderstorm.	Much damage to electric wires; damage estimated at thousands of dollars.	Official U. S. Weather Bureau.
Port Huron, Mich. (north of).	30	P. m.				do.	Trees uprooted.	Do.
Texas.	26					Wind and rain.	Heat wave which prevailed throughout the State was broken by wind and rain storms; no severe damage was done.	Dallas Morning News (Dallas, Tex.).

STORMS AND WARNINGS—WEATHER AND CROPS.

STORMS AND WEATHER WARNINGS.

WASHINGTON FORECAST DISTRICT.

No storm warnings were issued during August, except for the Atlantic coast from Cape Hatteras to Delaware Breakwater on the 26th in connection with falling barometer off the North Carolina coast and a strong area of high pressure to the northward. The highest wind velocity reported was 36 miles an hour from the northeast at Cape Henry.

Small-craft warnings were issued for Lake Huron on the 10th; for the Atlantic coast from Delaware Breakwater to Boston, Mass., on the 14th; and for Lakes Michigan and Huron and the Atlantic coast from Sandy Hook, N. J., to Portland, Me., on the 22d.

Frost warnings were issued for the cranberry bogs of New Jersey on the 22d.—*Charles L. Mitchell.*

CHICAGO FORECAST DISTRICT.

The only special warnings issued during the month of August in the Chicago Forecast District were those sent for light frost in the lowlands of North Dakota and northern Minnesota on August 13, and warnings for light frost to the Wisconsin cranberry marshes on the 13th, 14th, and 20th.

Most of the cranberry marshes were flooded on the dates in question as a result of these warnings, and no damage to the crop occurred.—*E. H. Haines.*

NEW ORLEANS FORECAST DISTRICT.

The month of August was exceptionally free from severe weather conditions. No storm warning was issued during the month, and no storm occurred without warning.—*I. M. Cline.*

DENVER FORECAST DISTRICT.

The usual summer conditions prevailed, with low, or relatively low, pressures in the southern Plateau sections, and frequent showers and thunderstorms and occasional heavy downpours in about all of this district. In western Arizona, however, there was little rain until the 20th, when showers were general in most of that State, with heavy rain in localities on both the 20th and 21st and in extreme southwestern Arizona on the 23d. An excessive rain in the vicinity of Canon City, Colo., on the evening of the 2d caused the Arkansas River to rise to a stage of 13.5 feet, the damage by the flood amounting to more than $250,000. The heaviest August rainfall of record in 24 hours at Denver, 2.93 inches, occurred on the night of the 23d–24th. Farming operations on the western slope of Colorado were delayed by wet weather, and considerable quantities of hay and grain were damaged toward the close of the month.

Moderately strong HIGHS moved across the northern Rocky Mountain region, from the north Pacific coast, on the 5th, 10th, 12th, and 19th. The more pronounced LOWS advanced from southwestern Canada eastward, or southeastward, to the Atlantic coast.

No special warnings were issued or required during the month.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT.

The weather in this district during August was marked by numerous depressions forming over the Plateau region and then moving slowly northeastward over the Rockies. These caused an unusual number of thunderstorms in Nevada and Idaho, and rainy periods in the North Pacific States from the 13th to the 18th, and again on the 23d and 24th.

On the 10th a heavy rain near Caliente, Nevada, damaged the Salt Lake and Los Angeles Railroad tracks and greatly delaying train service. Heavy rains and thunderstorms occurred in the Colorado Desert and Imperial Valley, doing some damage to crops and roads.

On the 31st a storm from the north Pacific passed far enough south to give rain in the western portions of Washington and Oregon.

Fire-weather warnings were issued in northern California on the 4th, and for the whole State on the 15th; the warnings read: "Rising temperature with drying northeasterly winds favorable for forest fires for the next three or four days." The warnings were timely and valuable.

Southwest storm warnings were issued on the 31st at all Washington stations. These were not verified.—*G. H. Willson.*

RIVERS AND FLOODS, AUGUST, 1921.

By H. C. FRANKENFIELD, Meteorologist.

[Weather Bureau, Washington, Sept. 29, 1921.]

The floods of August were confined to the Arkansas River of Colorado and the Salt River of Arizona, other rivers throughout the country having been at about their average stage for this season of the year.

Excessive rains fell near Canon City, Colo., on Aug. 2, causing the highest stage of record, 13.5 feet, in the Arkansas River at that place, at 7.15 p. m. same day. The rains were very local, and it was impossible to issue adequate warnings. Warnings, however, were issued for Colorado points east of Pueblo. The damage as reported from Canon City is as follows: Loss to tangible property, etc., $225,000; loss of prospective crops, $17,500; loss of live stock or other movable property, $4,250; loss due to suspension of business, $10,000. Total loss, $264,250. The flood stage was also exceeded in the Arkansas River at Pueblo and Fort Lyon, Colo., but with only slight damage.

On Aug. 21 unusually heavy rain fell near the headwaters of the Salt River, causing it to overflow considerably. At Phoenix, Ariz., the basement of the State capitol was flooded, damaging records to the extent of about $150,000. Numerous individuals suffered losses in the way of ranches, crops, etc., making the combined losses for the flood about $240,000.

Flood stages during August, 1921.

River.	Station.	Flood stage.	Above flood stages—dates.		Crest.	
			From—	To—	Stage.	Date.
Colorado drainage:		*Feet.*			*Feet.*	
Arkansas.....	Canon City, Colo.....	10	2	2	13.5	2
	Pueblo, Colo.....	10	2	3	11.7	2-3
	Fort Lyon, Colo.....	6	3	3	6.4	3

MEAN LAKE LEVELS DURING AUGUST, 1921.

By UNITED STATES LAKE SURVEY.

[Detroit, Mich., September 3, 1921.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.[1]			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during August, 1921:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sea level at New York	602.77	580.18	572.49	245.93
Above or below—				
Mean stage of July, 1921	+0.18	−0.26	−0.41	−0.44
Mean stage of August, 1920	−0.16	−0.83	−0.16	+0.31
Average stage for August, last 10 years	+0.10	−0.75	−0.14	−0.57
Highest recorded August, stage	−1.16	−3.33	−1.62	−2.33
Lowest recorded August, stage	+1.17	+0.33	+1.11	+1.58
Average relation of the August level to—				
July level		0.00	−0.20	−0.30
September level		+0.20	+0.20	+0.30

[1] Lake St. Clair's level: In August, 575.29 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, AUGUST, 1921.

By J. WARREN SMITH, Meteorologist.

The showery weather that had set in during the latter part of July over most of the interior portion of the country continued during the first half of August, with very beneficial effect on vegetation in that section. It continued dry, however, in the Southwest, including most of Texas and southwestern Oklahoma, while rain was needed in the North Central States and in the dry-farming districts of the Northwest. Considerably cooler weather prevailed in Central and Northern States until the last decade of the month, which also favorably affected cool-weather crops. The last decade was unseasonably warm in the central valleys and Northwest, and crops matured very rapidly during that period. No material frost damage was reported during the month.

The weather was unusually favorable for harvesting small grain crops in the late western and northwestern districts, and this work, as well as thrashing, made rapid progress. Thrashing was considerably delayed, however, in portions of the middle and upper Mississippi Valley by frequent rainfall, with considerable damage to grain in shock in some localities. Plowing for fall seeding made generally good progress in the principal winter-wheat section, with favoring soil condition. By the middle of the month some wheat had been sown in Montana and South Dakota.

The improvement in corn that was noted the latter part of July continued during the first half of August. By the middle of the month earlier drought had almost entirely been broken from the Ohio Valley northeastward, but it continued too dry in the southwestern Great Plains. Under the influence of unusually high temperatures in the principal corn States during the last decade of the month, the crop matured very rapidly, and by the close considerable corn was safe from frost in Iowa, Missouri, and Nebraska. At the close of the month rain was needed for late corn in many Southern States.

Warm, dry weather continued in the western portion of the cotton belt and cotton deteriorated in most of Texas and Oklahoma because of heat and drought. There was too much rain in some southeastern districts, where the plants made good growth, but put on little or no new fruit, and the crop was generally in unsatisfactory condition, with very little prospect of a top crop. The latter half of the month was generally dry in the cotton-growing States, and mostly poor progress or a general deterioration in the condition of the crop continued. The weather favored rapid opening of bolls, and picking and ginning were in progress at the close of the month in the southern and some central portions of the belt. There was some abatement of weevil activity in Texas and Florida, but they continued plentiful and very damaging in most districts.

Late potatoes, truck, and other miscellaneous crops were improved by rains in most interior States, but were unfavorably affected by dry weather in the Southwest and in much of the Atlantic coast section. Ranges and pastures suffered from lack of moisture in many eastern and southwestern States, as well as in parts of the Northwest. Ranges improved, however, in the lower Rocky Mountain and Plateau districts and stock continued in mostly good condition, except in parts of Texas, where range was poor and stock water scarce.

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation, by sections, August, 1921.

Section.	Temperature.								Precipitation.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	80.4	+0.9	Centerville	105	1	Valley Head	53	8	4.38	−0.48	Gadsden	9.40	Healing Springs	1.15
Arizona	77.5	−1.5	Gila Bend	115	13	3 stations	41	17	3.82	+1.40	Pinedale	9.00	Casa Grande	0.90
Arkansas	81.5	+2.4	2 stations	106	5†	Dodd City	56	8	5.46	+1.40	Arkadelphia	10.72	Junction	0.37
California	71.4	−1.4	Greenland Ranch	118	4†	Portola	20	23	0.10	+0.02	Needles	3.79	182 stations	0.00
Colorado	64.5	−0.1	2 stations	100	4†	Crested Butte	19	17	3.22	+1.17	Palisade Lake	8.41	Peetz	0.60
Florida	81.5	+0.3	Eustis	102	19	Mount Pleasant	57	28	4.33	−2.32	Apalachicola	10.53	Malabar	0.86
Georgia	79.3	−0.2	5 stations	103	1†	Blue Ridge	54	28	4.57	−0.95	Glennville	9.46	Lisbon	1.28
Hawaii (August)	74.9	0.0	Mahukona	94	28†	Waimea	51	3	4.35	−2.01	Honomu	21.34	6 stations	0.00
Idaho	66.9	+1.0	2 stations	108	12†	Stanley	22	5†	0.62	+0.05	Hawley Gulch R. S.	2.74	4 stations	0.00
Illinois	74.2	+0.1	Carbondale	102	2	3 stations	44	15	5.12	+1.81	Carbondale	10.73	Greenville	2.66
Indiana	72.9	−0.5	Huntingburg	100	20	3 stations	42	15†	5.35	+2.09	Winamac	8.79	Salamonia	2.77
Iowa	72.1	+0.3	2 stations	102	19†	New Hampton	37	8	5.04	+1.36	Postville	9.04	Cumberland	2.20
Kansas	78.6	+1.4	Salina	111	27	2 stations	48	8	3.51	+0.26	Lawrence	11.59	Elkhart	0.61
Kentucky	76.0	+0.3	Bowling Green	101	2	Greensburg	48	10	5.28	+1.72	Louisa	8.30	Marion	3.26
Louisiana	83.4	+1.7	Calhoun	107	21	Calhoun	59	29	3.31	−2.08	Houma	9.16	Rayne	0.80
Maryland-Delaware	71.3	−2.2	Millsboro, Del	98	31	Oakland, Md	37	28	3.71	−0.73	Wilmington, Del	6.45	Washington, D. C	1.10
Michigan														
Minnesota	67.7	+1.3	Beardsley	103	29	Angus	33	20	2.18	−1.04	Worthington	4.96	State Sanatorium	0.31
Mississippi	82.2	+1.9	3 stations	105	1	Batesville	59	10	3.78	−0.66	Poplarville	9.26	Moorhead	1.03
Missouri	76.8	+0.8	Caruthersville	109	19	2 stations	48	8†	5.27	+1.63	Marble Hill	10.04	Caruthersville	1.79
Montana	66.4	+1.8	Glasgow	104	30	Babb	21	26	0.57	−0.63	Anaconda	2.07	4 stations	0.00
Nebraska	73.8	+1.1	York	108	26	Harrison	37	7	2.50	−0.29	Brewster	7.42	Upland	0.47
Nevada	71.7	+0.4	Logandale	110	4†	Vya	30	29†	0.42	+0.09	Searchlight	3.25	10 stations	0.00
New England	65.4	−1.5	Somerset, Vt	96	30	2 stations	33	3†	2.85	−1.02	Millinocket, Me	6.34	Southington, Conn	0.43
New Jersey	69.8	−2.3	Elizabeth	97	30	Charlotteburg	38	23	4.32	−0.45	Trenton	8.01	Culvers Lake	2.05
New Mexico	69.8	−0.5	2 stations	104	6	Tres Piedras	30	29	2.80	+0.12	Harvey's Upper Ranch.	8.73	Pearl (near)	0.39
New York	66.7	−0.6	West Point	96	30	Bolivar	33	22	3.16	−0.70	Roslyn	7.21	Harkness	1.26
North Carolina	75.3	−0.3	Belhaven	104	31	Banners Elk	41	9	3.18	−2.45	Cullowhee	8.89	High Point	0.49
North Dakota	67.2	+1.8	Carson	108	31	Minot	31	20	1.92	−0.36	Melville	5.94	Skaar	0.03
Ohio	70.6	−1.1	Upper Sandusky	98	30	Canfield	40	19	4.21	+0.71	Greenfield	8.39	Kenton	1.38
Oklahoma	83.0	+2.1	2 stations	110	5†	Newkirk	52	7	2.14	−1.11	Woodward	6.85	Calvin	0.18
Oregon	65.6	−0.1	2 stations	105	7	Fremont	21	24	0.27	−0.23	Beech Creek	1.45	15 stations	0.00
Pennsylvania	68.4	−2.0	Lancaster	97	30	2 stations	35	23	3.83	−0.32	Waynesburg	6.68	Towanda	1.81
Porto Rico														
South Carolina	78.2	−0.6	3 stations	102	1†	3 stations	56	26†	4.14	−1.94	Georgetown	10.03	Camden	1.21
South Dakota	71.1	+0.9	Kennebec	104	18	Elk Mountain	32	7	2.52	+0.52	Menno	8.00	Orman	0.35
Tennessee	77.0	+0.4	Brownsville	102	1	Mountain City	44	27	5.65	+1.50	Covington	10.17	Kenton	1.66
Texas	84.3	+1.7	2 stations	110	5†	Dalhart	52	22†	1.00	−1.60	Amarillo	5.77	14 stations	0.00
Utah	68.7	−0.3	St. George	106	5	Black's Fork	29	16†	2.89	+0.95	Warner R. S	5.13	Midlake	0.03
Virginia	73.2	−1.4	West Point	103	2	Burkes Garden	40	9	2.43	−2.28	Wise	7.08	Lawrenceville	0.05
Washington	65.6	+0.6	Mottinger	104	7	Colfax	27	25	0.71	+0.01	Tatoosh Island	4.10	8 stations	0.00
West Virginia	69.7	−2.0	Wheeling	98	30	Bayard	37	28	5.20	+1.39	Clay	9.46	Upper Tract	2.13
Wisconsin	68.2	+1.3	Prairie du Sac	98	5	Park Falls	30	21	3.71	+0.56	Brodhead	8.96	Waupaca	0.67
Wyoming	64.0	+0.8	2 stations	100	18†	Riverside	22	5	0.84	−0.27	Big Creek	2.81	Hyattville	0.00

LATE REPORTS, JULY, 1921.

Hawaii	74.7	+0.6	2 stations	93	14†	Waimea	52	1	4.89	−0.53	Eke, Maui	21.00	11 station	0.00

†Other dates also.

TABLE I.—*Climatological data for Weather Bureau stations, August, 1921.*

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.											Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation.			Wind.						Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow, sleet, and ice on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean minimum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.							
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F*		*F°*	°*F.*		°*F*	°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles.*								*0.1*0	*In.*	*In.*
New England.							66.4	− 0.6											76	2.17	− 1.7										4.5		
Eastport	76	67	85	29.94	30.03	+ .07	60.6	+ 0.9	78	6	69	49	3	52	27	56	52	79	1.80	− 1.5	4	6,990	s.	49	se.	18	16	9	6	4.1	0.0	0.0
Greenville, Me	1,070	6	....	28.88	30.03	....	61.1	....	83	30	72	39	3	50	39	....	....	....	....	5.56	....	13	....	....	....	....	....	15	8	8	....	0.0	0.0
Portland, Me	103	82	117	29.94	30.06	+ .08	65.6	− 0.6	92	30	74	51	27	57	30	59	54	70	2.59	− 1.0	5	5,650	s.	32	se.	18	18	8	5	3.7	0.0	0.0
Concord	288	70	79	29.75	30.06	+ .08	65.6	− 1.0	92	30	78	43	23	53	34	....	....	....	1.60	− 2.1	6	3,228	se.	21	n.	1	19	9	3	3.2	0.0	0.0
Burlington	404	11	48	29.61	30.03	+ .08	66.0	− 0.1	86	30	76	45	2	56	33	....	....	....	2.98	− 1.0	9	7,529	s.	39	s.	6	10	10	11	5.3	0.0	0.0
Northfield	876	12	60	29.13	30.06	+ .08	62.4	− 0.5	87	30	75	38	23	50	37	57	54	78	3.51	− 0.4	7	4,622	s.	27	s.	11	6	18	7	5.7	0.0	0.0
Boston	125	115	188	29.93	30.06	+ .07	69.8	+ 0.9	92	30	78	55	27	62	25	63	60	72	1.63	− 2.4	5	6,737	sw.	30	nw.	18	18	10	3	4.0	0.0	0.0
Nantucket	12	14	90	30.06	30.07	+ .10	67.2	− 0.8	78	19	73	53	28	61	17	63	61	84	1.33	− 1.7	7	11,073	sw.	38	s.	18	12	11	8	5.2	0.0	0.0
Block Island	26	11	46	30.05	30.08	+ .09	67.2	− 1.5	76	19	72	56	22	62	17	63	62	85	3.05	− 0.4	7	10,237	sw.	35	w.	18	14	6	11	4.7	0.0	0.0
Providence	160	215	251	29.90	30.07	+ .08	68.6	− 2.4	91	30	78	49	27	60	26	62	58	71	1.88	− 2.2	6	7,953	sw.	39	nw.	14	14	11	6	4.2	0.0	0.0
Hartford	159	122	140	29.90	30.07	+ .08	68.9	0.0	93	30	79	49	27	59	29	62	58	72	1.29	− 3.3	9	5,040	s.	32	nw.	18	13	7	11	5.0	0.0	0.0
New Haven	106	74	153	29.97	30.08	+ .09	68.8	− 1.3	94	30	78	50	27	60	25	63	59	74	2.18	− 2.8	9	5,715	sw.	29	sw.	20	14	10	7	4.3	0.0	0.0
Middle Atlantic States.							71.7	− 1.1											73	3.36	− 1.0										4.5		
Albany	97	102	115	29.96	30.06	+ .08	69.2	− 0.3	94	30	79	50	22	59	27	62	57	70	2.67	− 1.3	8	5,018	s.	28	s.	6	19	10	2	3.3	0.0	0.0
Binghamton	871	10	84	29.16	30.07	+ .08	67.3	− 0.2	92	30	78	45	22	56	35	....	....	....	2.64	− 0.7	11	3,456	sw.	24	w.	30	12	11	8	4.9	0.0	0.0
New York	314	414	454	29.75	30.08	+ .08	70.9	− 1.3	91	30	78	58	15	64	21	63	59	71	3.87	− 0.7	7	9,870	s.	54	nw.	14	10	13	8	5.3	0.0	0.0
Harrisburg	374	94	104	29.70	30.10	+ .09	70.9	− 1.2	93	30	80	52	23	62	26	63	58	68	3.12	− 1.1	9	4,008	s.	21	n.	14	15	7	9	4.4	0.0	0.0
Philadelphia	117	123	190	29.97	30.09	+ .09	72.7	− 1.1	94	30	80	58	27	65	24	66	63	76	6.01	+ 1.4	10	5,967	s.	28	n.	21	8	14	9	4.9	0.0	0.0
Reading	325	81	98	29.75	30.09	....	71.0	....	94	30	80	53	22	62	28	63	59	70	4.13	+ 0.4	7	3,843	se.	24	n.	14	19	6	6	3.6	0.0	0.0
Scranton	805	111	119	29.24	30.09	+ .09	67.8	− 1.5	90	30	78	47	23	57	32	61	56	70	2.96	− 1.3	7	4,143	sw.	23	sw.	7	13	9	9	5.1	0.0	0.0
Atlantic City	52	37	48	30.03	30.08	+ .08	70.9	− 1.7	90	31	77	56	23	65	20	66	63	77	4.56	+ 0.3	11	4,985	s.	19	ne.	26	17	7	7	3.6	0.0	0.0
Cape May	18	13	49	30.10	30.12	+ .12	71.8	− 1.6	94	31	79	56	22	65	22	66	64	81	2.98	− 1.3	8	5,515	sw.	29	ne.	26	18	6	7	4.0	0.0	0.0
Sandy Hook	22	10	55	30.06	30.08	....	71.3	....	92	30	78	60	27	65	22	65	62	78	4.63	....	8	9,229	sw.	40	nw.	14	11	14	6	4.9	0.0	0.0
Trenton	190	159	183	29.88	30.08	....	70.2	....	92	30	79	54	27	61	25	64	60	74	8.01	+ 2.6	10	6,568	w.	40	s.	7	10	11	10	5.1	0.0	0.0
Baltimore	123	100	113	29.96	30.09	+ .08	73.9	− 0.8	94	31	82	59	23	66	21	66	61	68	3.49	− 0.7	9	3,983	s.	19	e.	20	16	8	7	4.5	0.0	0.0
Washington	112	62	85	29.97	30.09	+ .08	72.8	− 1.7	93	20	82	53	23	63	28	65	62	71	1.10	− 3.3	6	3,900	n.	22	nw.	12	13	9	9	5.1	0.0	0.0
Lynchburg	681	153	188	29.36	30.09	+ .07	74.5	− 0.3	95	2	86	52	27	64	31	66	62	69	0.83	− 3.4	9	4,662	w.	37	nw.	3	14	16	1	4.0	0.0	0.0
Norfolk	91	170	205	30.00	30.09	+ .09	76.4	− 0.4	95	31	84	62	16	69	23	69	66	74	3.13	− 2.8	10	8,940	ne.	62	nw.	3	10	16	5	4.6	0.0	0.0
Richmond	144	11	52	29.94	30.09	+ .08	76.6	− 0.9	101	2	88	54	27	65	31	67	63	70	0.61	− 3.8	7	4,995	ne.	37	w.	3	13	13	5	4.7	0.0	0.0
Wytheville	2,304	49	56	27.78	30.09	+ .08	68.2	− 2.3	89	2	77	48	27	59	28	63	61	81	3.72	− 0.8	11	3,589	w.	22	w.	2	13	12	6	4.4	0.0	0.0
South Atlantic States.							77.8	0.0											80	4.40	− 1.8										5.3		
Asheville	2,255	70	84	27.82	30.12	+ .10	70.6	+ 0.1	92	2	79	54	27	62	27	64	62	83	2.86	− 1.9	12	4,449	se.	26	e.	15	10	11	10	5.4	0.0	0.0
Charlotte	779	55	62	29.27	30.09	+ .07	76.1	− 0.5	98	1	84	58	27	68	25	68	65	74	2.78	− 2.8	12	2,895	sw.	27	nw.	3	10	5	16	6.2	0.0	0.0
Hatteras	11	12	50	30.06	30.08	+ .08	76.6	− 1.6	89	8	82	64	15	72	15	72	71	83	5.32	− 0.5	11	10,204	sw.	50	w.	3	13	10	8	4.6	0.0	0.0
Manteo	12	8	42	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Raleigh	376	103	110	29.69	30.08	+ .07	77.0	+ 0.2	97	31	86	57	27	68	25	69	65	73	1.62	− 4.3	8	5,661	sw.	31	w.	3	11	10	10	5.3	0.0	0.0
Wilmington	78	81	91	30.01	30.09	+ .09	77.6	0.0	94	31	85	58	26	70	21	72	70	83	3.50	− 3.0	15	5,380	sw.	37	ne.	26	12	11	8	4.8	0.0	0.0
Charleston	48	11	92	30.04	30.09	+ .08	80.8	+ 0.5	96	18	87	65	27	74	22	74	72	81	5.70	− 1.3	13	6,667	s.	33	ne.	4	12	12	7	4.7	0.0	0.0
Columbia, S. C	351	41	57	29.72	30.10	+ .09	78.5	− 1.0	97	1	87	61	26	70	23	70	68	78	3.62	− 3.2	11	4,220	ne.	26	sw.	3	9	15	7	5.4	0.0	0.0
Due West, S. C	711	10	55	29.36	30.12	....	76.8	....	100	1	86	60	27	68	29	....	....	....	6.42	....	11	5,080	ne.	41	nw.	21	8	9	14	6.2	0.0	0.0
Greenville, S. C	1,039	113	122	29.01	30.08	....	75.2	....	96	1	83	61	27	68	22	69	66	80	3.77	....	15	5,378	ne.	39	nw.	4	9	13	9	5.7	0.0	0.0
Augusta	180	62	77	29.89	30.08	+ .07	79.8	+ 0.9	98	1	88	64	26	71	26	73	70	80	2.01	− 3.6	14	3,296	s.	26	nw.	21	6	14	11	5.9	0.0	0.0
Savannah	65	150	194	30.02	30.09	+ .08	80.3	+ 0.9	97	1	89	63	27	72	22	73	72	83	8.88	+ 1.4	13	6,812	sw.	39	nw.	4	11	10	10	5.5	0.0	0.0
Jacksonville	43	209	245	30.04	30.09	+ .08	80.5	+ 0.4	96	19	88	66	27	74	22	75	73	85	7.70	+ 1.5	10	7,426	s.	48	s.	5	18	11	2	4.0	0.0	0.0
Florida Peninsula.							82.4	0.0											75	3.34	− 3.6										5.3		
Key West	22	10	64	30.01	30.03	+ .05	83.2	− 0.6	90	22	88	71	26	78	14	76	73	72	4.52	− 0.2	16	7,043	se.	34	s.	11	9	18	4	5.2	0.0	0.0
Miami	25	71	79	30.04	30.07	....	81.8	− 0.2	88	21	86	70	27	76	16	75	72	74	3.14	− 4.5	14	6,221	e.	22	e.	11	12	14	5	4.8	0.0	0.0
Sand Key	23	39	72	30.02	30.05	+ .07	81.0	....	89	21	84	72	11	78	13	76	74	77	2.29	....	18	9,435	e.	46	e.	11	8	16	7	5.3	0.0	0.0
Tampa	35	79	92	30.04	30.07	+ .07	82.2	+ 0.8	94	3	90	67	27	74	22	74	72	78	2.38	− 6.2	11	4,380	ne.	28	ne.	22	1	25	5	5.9	0.0	0.0
East Gulf States.							80.9	+ 1.7											79	4.29	− 0.6										5.5		
Atlanta	1,174	190	216	28.90	30.11	+ .10	76.7	+ 0.6	97	1	85	61	27	68	23	70	68	81	8.03	+ 3.6	13	6,083	nw.	36	nw.	7	5	6	20	7.1	0.0	0.0
Leesburg	279	10	55	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Macon	370	78	87	29.70	30.09	+ .08	79.4	+ 1.2	97	1	89	63	27	70	27	72	69	79	5.25	+ 1.0	11	3,475	s.	33	n.	21	8	11	12	5.9	0.0	0.0
Thomasville	273	49	58	29.79	30.08	+ .08	81.0	0.0	97	22	91	61	27	71	25	73	71	80	3.56	− 1.5	13	2,711	ne.	19	sw.	16	7	14	10	5.9	0.0	0.0
Pensacola	56	149	185	30.01	30.07	+ .09	81.2	+ 0.2	94	19	87	69	29	76	17	75	73	79	3.29	− 3.9	11	8,316	sw.	32	sw.	7	8	15	8	5.4	0.0	0.0
Anniston	741	9	57	29.32	30.10	+ .11	78.8	+ 2.4	102	1	89	59	28	68	31	....	....	....	3.04	− 1.4	14	2,936	se.	22	se.	24	7	20	4	5.0	0.0	0.0
Birmingham	700	11	48	29.35	30.10	+ .11	80.3	+ 0.5	101	1	90	65	28	71	26	71	69	77	3.97	− 0.5	12	3,764	s.	25	nw.	7	10	12	9	5.3	0.0	0.0
Mobile	57	125	161	30.00	30.06	+ .08	82.5	+ 2.8	99	22	91	69	29	74	23	75	73	80	8.37	+ 1.6	17	6,165	sw.	53	e.	6	6	24	1	5.1	0.0	0.0
Montgomery	223	100	112	29.84	30.08	+ .09	81.6	+ 1.9	100	1	91	65	28	72	26	73	71	79	3.49	− 0.8	11	4,080	e.	28	sw.	7	8	15	8	5.1	0.0	0.0
Meridian	375	85	93	29.67	30.05	+ .07	81.3	+ 2.8	100	1	91	64	27	72	27	73	70	78	3.80	+ 0.2	13	3,417	sw.	26	nw.	18	11	19	1	4.7	0.0	0.0
Vicksburg	247	65	73	29.80	30.07	+ .09	82.6	+ 3.0	96	22	91	68	27	74	23	74	72	79	1.35	− 2.2	6	4,273	sw.	22	n.	8	14	11	6	4.7	0.0	0.0
New Orleans	53	76	84	30.00	30.05	+ .07	84.2	+ 3.2	99	21	92	69	28	77	19	75	73	76	3.09	− 2.5	12	3,413	sw.	22	e.	25	1	20	10	6.3	0.0	0.0
West Gulf States.							83.2	+ 2.2											72	1.90	− 1.0										3.7		
Shreveport	249	77	93	29.77	30.03	+ .06	84.0	+ 2.6	101	21	94	69	30	74	26	73	70	69	0.64	− 1.6	3	4,506	s.	24	e.	25	23	4	4	3.1	0.0	0.0
Bentonville	1,303	11	44	....	....	....	78.4	+ 1.9	96	5	88	59	8	68	....	....	....	....	7.89	....	11	....	s.	....	....	....	11	14	6	....	0.0	0.0
Fort Smith	457	79	94	29.52	29.99	+ .02	82.7	+ 3.3	101	6	92	68	7	73	29	74	71	76	4.45	+ 0.8	10	4,717	e.	51	w.	2	12	11	8	4.5	0.0	0.0
Little Rock	357	136	144	29.65	30.02	+ .04	81.4	+ 2.2	97	24	90	68	4	72	25	73	71	78	7.08	+ 3.4	11	4,807	s.	33	nw.	4	12	11	8	4.5	0.0	0.0
Brownsville	57	4	26	....	....	....	84.2	....	97	20	95	67	30	74	29	....	....	....	0.14	....	2	....	se.	....	....	....	....	....	....	....	....	0.0	0.0
Corpus Christi	20	69	77	29.98	30.00	+ .07	83.0	+ 0.9	94	5	89	74	30	77	18	76	75	81	0.32	− 2.0	2	9,068	se.	31	se.	17	26	5	0	2.2	0.0	0.0
Dallas	512	109	117	29.46	29.99	....	86.0	....	102	25	96	70	31	76	26	....	....	....	1.12	....	1	5,948	s.	33	s.	15	17	9	5	3.6	0.0	0.0
Fort Worth	670	106	114	29.26	29.96	+ .02	86.4	+ 3.5	102	21	97	68	30	76	28	71	65	58	0.95	− 0.9	4	6,779	s.	25	se.	26	18	9	4	3.4	0.0	0.0
Galveston	54	106	114	29.99	30.05	+ .09	83.6	+ 1.0	96	22	88	73	30	79	17	76	73	75	1.42	− 3.6	8	6,580	se.	28	e.	31	17	13	1	4.0	0.0	0.0
Groesbeck	461	11	56	29.53	30.00	....	83.6	....	101	22	96	66	30	72	32	....	....	....	0.49	....	2	6,844	s.	32	se.	26	18	11	2	2.7	0.0	0.0
Houston	138	111	121	29.88	30.02	....	83.9	+ 1.0	100	22	93	68	29	74	26	....	....	....	1.66	....	7	4,655	s.	29	ne.	31	5	22	4	4.8	0.0	0.0
Palestine	510	64	72	29.50	30.02	+ .05	82.8	+ 2.3	101	22	93	66	30	73	28	72	69	70	0.84	− 1.4	3	4,733	s.	27	se.	26	14	13	4	4.5	0.0	0.0
Port Arthur	34	58	66	29.99	30.03	....	82.6	....	98	22	90	69	25	75	22	75	73	79	3.90	....	13	5,550	sw.	29	e.	25	18	10	3	3.1	0.0	0.0
San Antonio	701	119	132	29.28	29.99	+ .06	85.2	+ 3.2	100	22	96	70	30	74	27	72	66	62	0.45	− 2.2	2	5,625	se.	27	ne.	26	19	10	2	3.1	0.0	0.0
Taylor	582	55	63	29.94	30.05	+ .10	84.2	+ 2.5	100	22	95	66	29	73	29	....	....	....	0.91	− 1.6	1	5,941	s.	25	s.	16	14	14	3	4.0	0.0	0.0

TABLE I.—*Climatological data for Weather Bureau stations, August, 1921*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.											Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation.			Wind.						Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow, sleet, and ice on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.							
Ohio Valley and Tennessee.	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles.*								*0.10*	*In.*	*In.*
							74.4	− 0.2											74	4.69	+ 1.3										5.0		
Chattanooga	762	189	213	29.30	30.09	+ .09	77.4	+ 0.6	95	1	86	61	9	69	28	70	67	76	4.88	+ 1.1	14	4,054	se.	43	sw.	6	6	17	8	5.9	0.0	0.0
Knoxville	996	102	111	29.04	30.08	+ .07	76.6	+ 1.9	93	1	85	61	9	68	26	69	67	78	2.86	− 1.1	13	4,036	sw.	30	sw.	7	9	6	16	6.3	0.0	0.0
Memphis	399	76	97	29.65	30.07	+ .09	80.8	+ 1.6	95	1	88	68	8	73	20	73	70	75	5.84	+ 2.6	11	4,786	sw.	30	nw.	6	14	12	5	4.2	0.0	0.0
Nashville	546	168	191	29.50	30.08	+ .08	78.0	+ 0.2	96	1	87	60	9	69	29	70	67	75	2.85	− 0.6	12	4,921	sw.	47	nw.	6	7	15	9	5.5	0.0	0.0
Lexington	989	193	230	29.02	30.07	+ .06	74.6	0.0	92	2	84	55	15	66	25	.....	.....	.....	3.88	+ 0.3	10	8,307	sw.	45	n.	20	11	12	8	5.0	0.0	0.0
Louisville	525	219	255	29.49	30.07	+ .07	76.5	0.0	96	2	85	60	15	68	26	68	64	71	5.40	+ 1.9	11	6,462	s.	37	w.	20	15	10	6	4.5	0.0	0.0
Evansville	431	139	175	29.60	30.06	+ .07	77.0	0.0	95	20	86	59	15	68	24	69	65	71	5.26	+ 2.0	11	6,200	sw.	48	nw.	20	7	18	6	4.9	0.0	0.0
Indianapolis	822	194	230	29.18	30.05	+ .05	73.2	− 0.4	88	26	82	55	22	64	28	66	62	70	7.26	+ 3.9	10	6,911	s.	42	n.	1	9	15	7	5.2	0.0	0.0
Royal Center	736	11	55	29.27	30.05	.....	70.4	.....	88	30	80	50	15	60	29	.....	.....	.....	6.31	.....	13	5,659	s.	37	w.	25	8	14	9	5.6	0.0	0.0
Terre Haute	575	96	129	29.41	30.02	.....	74.0	.....	90	1	84	54	21	64	30	67	63	73	4.27	.....	10	5,715	s.	25	w.	17	8	17	6	5.7	0.0	0.0
Cincinnati	628	11	51	29.40	30.06	+ .05	72.8	− 0.7	90	29	83	53	22	62	29	.....	64	75	6.02	+ 2.7	12	3,924	ne.	22	nw.	7	16	9	6	4.1	0.0	0.0
Columbus	824	179	222	29.22	30.08	+ .07	71.7	− 1.3	89	29	82	53	15	62	30	64	60	70	4.55	+ 1.3	10	5,657	sw.	64	nw.	6	17	8	6	3.7	0.0	0.0
Dayton	899	181	216	29.09	30.03	.....	72.5	− 1.1	89	30	82	53	15	63	29	65	60	69	3.30	+ 0.3	9	5,676	sw.	35	nw.	7	16	10	5	3.9	0.0	0.0
Elkins	1,947	59	67	28.09	30.10	+ .08	67.6	− 0.8	84	2	78	45	28	57	39	62	60	84	6.82	+ 3.2	9	2,820	s.	23	nw.	2	6	11	14	6.2	0.0	0.0
Parkersburg	638	77	84	29.44	30.10	+ .09	72.4	− 0.9	90	30	83	54	22	62	31	64	61	74	3.71	+ 0.2	8	3,098	se.	22	nw.	2	14	9	8	4.9	0.0	0.0
Pittsburgh	842	353	410	29.19	30.08	+ .07	70.2	− 2.3	88	30	80	51	23	61	30	62	58	70	3.03	− 0.2	10	6,123	se.	36	sw.	11	13	6	12	4.9	0.0	0.0
Lower Lake Region.							69.3	− 0.3											68	2.94	0.0										4.9		
Buffalo	767	247	280	29.24	30.06	+ .07	68.3	− 0.5	83	11	75	53	21	62	24	61	56	67	1.80	− 1.2	8	10,287	s.	47	sw.	6	9	11	11	5.5	0.0	0.0
Canton	448	10	61	29.55	30.02	.....	66.8	− 1.0	86	10	77	45	3	56	32	.....	.....	.....	3.91	+ 1.2	9	6,397	sw.	31	sw.	7	11	14	6	5.0	0.0	0.0
Oswego	335	76	91	29.68	30.04	+ .05	67.8	− 1.0	87	11	75	51	23	60	26	61	56	69	1.49	− 1.2	8	6,594	s.	33	ne.	20	13	11	7	4.6	0.0	0.0
Rochester	523	86	102	29.50	30.07	+ .08	68.8	+ 0.5	88	30	78	48	22	60	26	60	55	65	2.60	− 0.4	9	5,298	sw.	25	w.	30	11	10	10	5.3	0.0	0.0
Syracuse	597	97	113	29.44	30.08	+ .09	68.4	− 0.2	89	30	77	49	23	60	25	.....	.....	.....	2.39	− 0.9	9	7,235	s.	42	sw.	11	11	14	6	5.0	0.0	0.0
Erie	714	130	166	29.30	30.06	+ .05	69.2	− 0.7	87	28	77	51	22	61	24	63	59	71	4.30	+ 1.0	9	9,319	s.	48	w.	17	13	13	5	4.5	0.0	0.0
Cleveland	762	190	201	29.26	30.07	+ .06	69.3	− 1.1	88	30	77	53	22	62	23	62	58	69	3.32	+ 0.2	9	8,608	s.	42	sw.	6	13	10	8	4.5	0.0	0.0
Sandusky	629	62	103	29.39	30.06	+ .05	71.0	− 0.5	91	29	79	54	22	62	27	.....	.....	.....	3.49	+ 0.1	8	7,010	s.	30	w.	6	10	13	8	5.1	0.0	0.0
Toledo	628	208	243	29.39	30.06	+ .06	70.8	− 0.1	90	31	79	53	21	62	23	63	59	69	2.71	0.0	11	8,421	sw.	30	nw.	6	15	10	6	4.3	0.0	0.0
Fort Wayne	856	113	124	29.15	30.06	.....	71.4	+ 0.3	89	30	81	52	22	62	30	63	58	68	4.05	.....	10	5,699	sw.	34	nw.	19	11	12	8	5.2	0.0	0.0
Detroit	730	218	245	29.28	30.06	+ .05	70.5	+ 0.6	87	30	78	55	21	63	22	63	58	70	3.43	+ 0.7	11	6,648	sw.	42	nw.	30	13	9	9	4.9	0.0	0.0
Upper Lake Region.							67.0	+ 0.6											75	4.41	+ 1.4										5.2		
Alpena	609	13	92	29.37	30.04	+ .04	64.4	+ 0.6	88	29	73	45	21	56	36	60	57	79	4.15	+ 0.8	10	7,007	se.	33	nw.	14	8	14	9	5.7	0.0	0.0
Escanaba	612	54	60	29.35	30.01	+ .02	64.6	+ 0.1	80	30	72	47	21	57	28	60	57	78	4.97	+ 1.4	7	6,728	s.	25	nw.	7	15	8	8	4.4	0.0	0.0
Grand Haven	632	54	89	29.36	30.03	+ .04	67.4	− 0.4	86	25	75	46	21	60	26	62	59	77	5.80	+ 3.2	13	6,514	s.	37	nw.	19	10	12	9	5.0	0.0	0.0
Grand Rapids	707	70	87	29.29	30.04	+ .04	70.6	+ 0.6	90	19	80	49	21	61	29	63	58	70	6.15	+ 3.6	11	3,277	se.	26	nw.	13	7	13	11	6.0	0.0	0.0
Houghton	684	62	99	29.28	30.00	+ .03	64.4	+ 1.1	90	29	74	49	21	55	34	.....	.....	.....	1.51	− 1.4	7	6,405	e.	40	w.	7	10	12	9	5.6	0.0	0.0
Lansing	878	11	62	29.11	30.04	.....	68.6	0.0	88	31	80	45	15	58	32	61	59	78	5.18	+ 2.6	7	3,055	sw.	18	nw.	17	7	15	9	5.5	0.0	0.0
Ludington	637	60	66	29.34	30.03	.....	66.3	.....	84	25	73	47	21	60	25	62	58	76	4.35	.....	7	6,534	s.	32	s.	19	17	7	7	4.2	0.0	0.0
Marquette	734	77	111	29.23	30.03	+ .05	64.2	+ 0.7	90	29	73	49	2	56	33	59	56	76	3.48	+ 0.6	10	6,772	w.	37	s.	19	4	20	7	6.2	0.0	0.0
Port Huron	638	70	120	29.36	30.05	+ .05	68.1	+ 0.8	90	30	77	50	15	60	28	62	59	75	3.34	+ 0.7	12	6,446	sw.	47	nw.	30	8	17	6	5.0	0.0	0.0
Saginaw	641	69	77	29.36	30.04	.....	68.8	.....	88	30	79	48	21	59	30	62	59	76	3.63	+ 0.8	10	4,931	sw.	26	sw.	10	10	13	8	5.4	0.0	0.0
Sault Sainte Marie	614	11	52	29.33	30.02	+ .03	63.4	+ 2.8	85	5	72	46	9	55	34	58	56	78	3.48	+ 0.3	10	4,926	nw.	28	nw.	14	10	12	9	5.4	0.0	0.0
Chicago	823	140	310	29.17	30.04	+ .04	72.8	+ 1.6	91	19	78	61	8	67	24	64	60	67	4.92	+ 2.0	14	7,485	ne.	33	s.	19	16	8	7	4.3	0.0	0.0
Green Bay	617	109	144	29.35	30.01	+ .02	69.0	+ 0.3	88	9	78	50	21	60	27	62	59	75	4.97	+ 1.9	6	7,023	s.	39	s.	10	9	11	11	5.6	0.0	0.0
Milwaukee	681	125	139	29.30	30.03	+ .03	69.8	+ 1.1	90	29	77	54	21	63	27	62	59	73	7.27	+ 4.4	10	6,386	sw.	39	ne.	26	7	15	9	5.5	0.0	0.0
Duluth	1,133	11	47	28.80	30.00	+ .03	63.6	− 1.3	91	29	72	48	20	55	33	58	55	77	2.84	− 0.7	9	7,811	ne.	43	sw.	9	13	13	5	4.1	0.0	0.0
North Dakota.							68.0	+ 1.2											62	2.54	+ 0.4										4.9		
Moorhead	940	50	58	28.98	29.98	+ .02	68.2	+ 2.3	93	9	80	44	20	56	37	59	54	68	3.94	+ 0.8	11	5,420	s.	26	nw.	6	10	17	4	4.4	0.0	0.0
Bismarck	1,674	8	57	28.24	29.99	+ .05	70.2	+ 2.1	100	31	85	44	14	56	42	58	50	58	0.18	− 1.0	6	6,720	se.	34	nw.	4	13	15	3	4.3	0.0	0.0
Devils Lake	1,482	11	44	28.40	29.96	+ .02	65.5	+ 0.4	93	31	79	41	7	52	37	57	52	68	5.63	+ 2.9	10	6,552	s.	36	w.	4	18	7	6	3.7	0.0	0.0
Ellendale	1,457	10	56	28.45	30.00	.....	67.1	.....	93	29	82	40	7	53	44	.....	.....	.....	2.19	.....	9	8,624	s.	62	se.	27	13	15	3	4.2	0.0	0.0
Grand Forks	835	12	89	.....	.....	.....	66.0	.....	92	31	79	38	20	53	41	.....	.....	.....	2.53	.....	7	.....	e.	65	w.	5	19	9	3	.....	0.0	0.0
Williston	1,878	41	48	27.98	29.92	− .01	68.1	+ 0.2	97	31	83	44	23	54	43	56	48	56	0.40	− 0.9	3	5,699	se.	40	nw.	4	19	12	0	2.9	0.0	0.0
Upper Mississippi Valley.							73.1	+ 0.5											74	4.40	+ 1.1										4.8		
Minneapolis	918	102	208	29.01	29.97	.....	70.4	+ 0.9	92	29	80	51	20	61	27	.....	.....	.....	2.03	− 1.7	7	7,410	s.	47	nw.	26	9	17	5	4.9	0.0	0.0
St. Paul	837	236	261	29.11	30.00	+ .03	70.0	+ 0.5	91	29	80	51	21	60	30	.....	.....	.....	2.79	− 0.7	7	7,725	se.	48	w.	9	10	19	2	4.3	0.0	0.0
La Crosse	714	11	48	29.25	30.00	+ .02	70.6	+ 0.6	94	29	82	46	21	60	37	.....	.....	.....	1.26	− 2.2	6	2,879	s.	16	sw.	9	9	18	4	4.6	0.0	0.0
Madison	974	70	78	29.01	30.03	+ .04	70.0	+ 0.4	89	19	78	53	21	62	24	63	59	75	3.97	+ 0.8	7	5,135	s.	37	nw.	19	4	22	5	5.6	0.0	0.0
Wausau	1,247	4	.....	28.70	30.01	.....	67.6	.....	89	29	79	42	21	56	34	.....	.....	.....	2.02	.....	8	.....	se.	.....	.....	.....	.....	.....	10	10	11	5.5	0.0	0.0
Charles City	1,015	10	49	28.96	30.01	+ .04	69.8	− 0.9	92	29	80	49	21	59	32	63	60	76	6.74	+ 3.3	6	3,866	s.	18	sw.	9	10	17	4	4.9	0.0	0.0
Davenport	606	71	79	29.37	30.02	+ .04	73.4	+ 0.4	93	29	82	55	21	65	24	67	64	77	6.62	+ 3.0	10	4,925	e.	30	e.	1	12	10	9	5.1	0.0	0.0
Des Moines	861	84	97	29.08	29.97	.00	73.2	+ 0.2	99	19	83	56	8	64	29	66	62	73	6.63	+ 3.0	9	4,831	se.	24	n.	22	17	8	6	4.2	0.0	0.0
Dubuque	698	81	96	29.30	30.04	+ .06	71.6	− 0.4	94	19	80	52	21	63	28	64	61	76	4.29	+ 1.2	11	3,901	s.	29	nw.	30	7	17	7	5.6	0.0	0.0
Keokuk	614	64	78	29.35	30.02	+ .04	75.1	+ 0.5	96	19	84	56	15	66	28	67	64	71	5.34	+ 2.1	9	4,430	s.	35	s.	5	8	15	8	5.3	0.0	0.0
Cairo	356	87	93	29.66	30.03	+ .04	77.6	+ 0.6	96	20	86	64	15	70	24	70	68	77	4.29	+ 0.4	8	4,752	s.	38	ne.	6	8	12	11	5.6	0.0	0.0
Peoria	609	11	45	29.38	30.04	+ .05	73.8	+ 1.3	93	19	84	52	8	64	30	67	64	75	3.86	+ 0.9	10	3,506	s.	22	w.	17	17	9	5	3.5	0.0	0.0
Springfield, Ill	644	10	91	29.34	30.01	+ .02	74.8	+ 0.8	95	19	85	53	15	65	30	68	65	76	5.18	+ 2.4	10	5,231	s.	33	nw.	1	10	14	7	5.1	0.0	0.0
Hannibal	534	74	109	29.44	30.01	+ .03	75.9	+ 0.9	96	19	85	56	15	66	29	.....	.....	.....	5.78	+ 2.4	10	5,564	sw.	34	nw.	5	14	13	4	4.2	0.0	0.0
St. Louis	567	265	303	29.42	30.01	+ .02	77.5	+ 0.3	97	19	86	57	15	69	25	68	64	67	2.75	+ 0.1	10	8,438	s.	48	nw.	6	14	12	5	4.3	0.0	0.0
Missouri Valley.							74.9	+ 1.1											73	4.59	− 1.2										4.4		
Columbia, Mo	781	11	84	29.19	30.00	+ .03	76.4	+ 1.7	96	19	86	55	8	67	28	.....	.....	.....	5.83	+ 2.8	13	4,403	s.	35	nw.	6	15	12	4	4.0	0.0	0.0
Kansas City	963	161	181	28.97	29.98	+ .01	77.0	+ 1.2	96	23	85	59	15	69	28	70	66	73	6.23	+ 1.5	12	6,849	s.	44	w.	16	12	13	6	4.4	0.0	0.0
St. Joseph	967	11	49	28.96	29.96	.....	77.1	.....	98	23	87	57	8	67	30	68	65	74	4.84	.....	12	5,166	se.	32	nw.	1	17	9	5	3.6	0.0	0.0
Springfield, Mo	1,324	98	104	28.65	30.02	+ .05	77.0	+ 2.2	96	5	86	61	8	63	27	70	68	78	7.59	+ 3.3	11	6,500	s.	35	nw.	11	12	14	5	4.4	0.0	0.0
Ioka	988	11	50	28.96	29.98	+ .02	78.4	+ 2.1	99	23	88	57	8	68	29	.....	.....	.....	5.79	+ 2.3	14	4,183	s.	22	nw.	5	11	12	8	5.3	0.0	0.0
Topeka	987	92	107	.....	.....	.....	77.6	+ 1.6	99	23	87	60	8	68	31	.....	.....	.....	9.73	+ 5.4	8	7,062	s.	44	nw.	16	13	12	6	4.2	0.0	0.0
Drexel	1,299	10	53	28.60	29.96	.....	73.4	.....	96	26	84	52	7	62	31	66	63	77	1.69	.....	9	5,916	s.	28	s.	16	14	12	5	4.3	0.0	0.0
Lincoln	1,189	11	84	28.71	29.94	− .01	76.4	+ 2.1	103	25	88	55	3	65	37	68	65	75	3.43	− 0.3	9	5,731	se.	66	w.	26	14	5	12	5.0	0.0	0.0
Omaha	1,105	115	122	28.83	29.98	+ .02	75.6	+ 1.2	97	19	86	57	7	66	28	67	63	72	2.07	− 1.6	11	5,123	se.	28	ne.	19	13	13	5	4.4	0.0	0.0
Valentine	2,598	47	54	27.32	29.99	+ .05	71.1	− 0.2	98	18	84	46	7	59	40	61	57	68	1.60	− 1.2	10	6,381	s.	30	nw.	9	13	13	5	4.1	0.0	0.0
Sioux City	1,135	94	164	28.80	29.99	+ .04	72.8	+ 0.2	93	29	83	53	7	63	34	64	61	72	3.17	+ 0.2	11	7,391	s.	40	nw.	16	10	14	7	4.9	0.0	0.0
Huron	1,306	59	74	28.62	30.00	+ .05	70.6	+ 1.5	94	29	82	47	14	60	39	63	60	74	3.22	+ 0.6	11	5,861	se.	44	nw.	9	11	14	6	4.1	0.0	0.0
Pierre	1,572	70	75	28.32	29.96	+ .02	74.0	+ 0.9	102	18	87	49	14	61	39	63	57	64	1.59	− 0.4	8	6,321	se.	41	n.	29	17	6	3	4.3	0.0	0.0
Yankton	1,233	49	57	28.67	29.97	+ .02	72.0	− 0.8	94	18	82	50	14	62	38	.....	.....	.....	4.85	+ 1.7	9	4,552	ne.	32	nw.	28	11	15	5	5.2	0.0	0.0

TABLE I.—*Climatological data for Weather Bureau stations, August, 1921*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.										Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity.	Precipitation.			Wind.						Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow, sleet, and ice on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to mean of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with 0.01 or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.							
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	*In.*	*In.*		*Miles.*								*0.10*	*In.*	*In.*
Northern Slope.							**67.1**	**+ 0.9**										**53**	**1.00**	**− 0.2**										**4.0**		
Billings	3,140	5					70.6		99	8	91	40	7	50	55				0.51		5		nw.				7	19	5		0.0	0.0
Havre	2,505	11	44	27.35	29.94	+ .03	69.0	+ 2.1	99	30	85	43	7	53	49	55	45	52	0.27	− 1.0	3	4,228	e.	30	nw.	4	17	13	1	3.4	0.0	0.0
Helena	4,110	87	112	25.83	29.94	.00	67.9	+ 1.8	93	30	82	45	19	54	39	52	40	43	0.68	0.0	8	6,054	sw.	46	sw.	3	14	14	3	4.0	0.0	0.0
Kalispell	2,973	48	56	26.91	29.91	− .02	64.0	+ 1.1	89	30	79	39	25	49	41	51	40	48	0.56	+ 0.3	5	4,365	nw.	30	w.	8	21	8	2	3.3	0.0	0.0
Miles City	2,371	26	48																															
Rapid City	3,259	50	58	26.65	29.99	+ .06	70.5	+ 1.7	97	31	83	46	7	58	36	58	50	55	1.99	− 0.1	12	5,303	w.	34	nw.	4	10	15	6	4.8	0.0	
Cheyenne	6,088	84	101	24.14	29.99	+ .07	65.6	− 0.2	87	4	78	43	17	53	37	53	45	56	0.61	− 0.9	9	7,712	w.	37	w.	16	12	14	5	4.5	0.0	0.0
Lander	5,372	60	68	24.74	29.98	+ .06	66.5	+ 0.8	92	12	82	43	6	51	43	52	42	49	0.30	− 0.2	8	3,807	sw.	44	w.	15	12	17	2	4.0	0.0	0.0
Sheridan	3,760	10	47	26.15	29.98		68.0		94	21	85	38	7	51	46	54	44	51	0.24		3	3,450	nw.	27	se.	23	19	11	1	3.1	0.0	0.0
Yellowstone Park	6,200	11	48	24.00	30.00	+ .07	60.2	− 0.7	82	30	75	38	5	45	39	48	39	53	1.03	0.0	11	5,245	s.	32	s.	17	9	19	3	4.9	0.0	0.0
North Platte	2,821	11	51	27.14	30.01	+ .07	73.0	+ 0.8	97	28	86	52	7	60	37	63	60	72	2.57	+ 0.1	6	4,792	se.	27	nw.	16	18	7	6	3.7	0.0	0.0
Middle Slope.							**77.2**	**+ 2.0**										**62**	**2.35**	**+ 0.1**										**4.3**		
Denver	5,292	106	113	24.85	30.01	+ .09	71.2	+ 0.8	92	4	83	51	6	60	36	57	50	55	3.49	+ 2.2	9	4,872	s.	34	nw.	6	11	14	6	4.6	0.0	0.0
Pueblo	4,685	80	86	25.38	29.97	+ .06	72.8	+ 0.7	93	4	86	52	7	60	36	60	53	59	2.24	+ 0.7	10	4,088	nw.	30	nw.	13	8	20	3	4.8	0.0	0.0
Concordia	1,392	50	58	28.52	29.96	+ .01	78.9	+ 2.4	104	26	91	56	3	67	33	66	61	63	1.93	− 0.9	9	5,464	s.	38	nw.	19	15	12	4	4.5	0.0	0.0
Dodge City	2,509	11	51	27.44	29.98	+ .05	77.8	+ 1.3	100	27	90	54	7	66	32	65	60	63	2.65	+ 0.1	11	6,498	sw.	29	ne.	13	20	10	1	2.9	0.0	0.0
Wichita	1,358	139	158	28.55	29.95	.00	79.8	+ 2.3	101	26	90	56	7	69	31	69	64	66	4.14	+ 1.0	9	8,539	s.	46	sw.	12	13	15	3	4.2	0.0	0.0
Altus	1,410	5					84.4		107	5	98	63	31	70	39				1.16		7		se.				19	3	9		0.0	0.0
Broken Arrow	765	11	52	29.18	30.00		80.3		102	5	90	62	7	70	33				4.81		8	7,907	s.	72	nw.	6	14	10	7	4.4	0.0	0.0
Muskogee	652	4					83.8		104	23	96	65	4	72	35				2.89		9		nw.				15	7	9		0.0	0.0
Oklahoma City	1,214	10	47	28.72	29.97	+ .03	82.9	+ 4.4	102	26	94	62	3	72	30	70	65	63	0.85	− 2.3	8	7,729	s.	34	n.	7	15	10	6	4.4	0.0	0.0
Southern Slope.							**81.2**	**+ 2.0**										**56**	**1.98**	**− 0.2**										**2.6**		
Abilene	1,738	10	52	28.19	29.94	+ .02	85.4	+ 4.2	102	6	98	64	31	73	31	68	59	49	0.91	− 1.1	3	6,540	s.	26	se.	28	20	9	2	2.8	0.0	0.0
Amarillo	3,676	10	49	26.34	29.98	+ .06	76.4	+ 1.8	97	10	88	58	31	64	30	64	59	63	5.77	+ 3.0	6	6,570	s.	29	sw.	10	23	8	0	3.0	0.0	0.0
Del Rio	944	64	71	29.00	29.96	+ .06	85.2	+ 1.2	99	6	96	68	26	75	29				0.49	− 2.1	2	7,810	se.	48	se.	26	26	5	0	1.2	0.0	0.0
Roswell	3,566	75	85	26.40	29.93	+ .05	77.6	+ 1.0	98	6	91	59	22	64	37	63	55	55	0.77	− 0.7	5	4,374	s.	30	se.	30	13	17	1	3.5	0.0	0.0
Southern Plateau.							**77.0**	**− 0.3**										**51**	**1.99**	**+ 0.6**										**3.5**		
El Paso	3,762	110	133	26.21	29.88	+ .04	80.4	+ 1.8	98	6	91	64	17	70	27	64	55	48	0.35	− 1.4	6	6,670	se.	40	ne.	12	19	12	0	3.2	0.0	0.0
Santa Fe	7,013	57	66	23.41	29.96	+ .07	66.0	− 1.0	86	6	77	49	31	55	28	55	50	66	3.71	+ 1.4	15	4,496	e.	33	s.	20	4	21	6	5.4	0.0	0.0
Flagstaff	6,908	10	59				63.0	+ 0.2	80	13	75	47	26	51	33				4.74	+ 2.0	17	4,430	w.	25	w.	8	7	19	5		0.0	0.0
Phoenix	1,108	76	81	28.71	29.83	+ .04	87.1	− 1.9	107	13	99	70	1	75	32	71	64	52	1.62	+ 0.7	6	3,583	e.	36	ne.	19	10	16	5	4.5	0.0	0.0
Yuma	141	9	54	29.67	29.81	+ .05	89.6	− 0.5	110	13	102	71	17	77	35	73	67	56	1.44	+ 1.1	3	3,201	sw.	28	se.	19	22	9	0	2.1	0.0	0.0
Independence	3,957	9	41	25.98	29.93	+ .12	76.1	− 0.3	100	6	91	55	19	61	38	55	37	31	0.08	0.0	1	4,401	s.	22	s.	27	23	7	1	2.2	0.0	0.0
Middle Plateau.							**71.1**	**− 0.5**										**42**	**1.35**	**+ 0.6**										**3.1**		
Reno	4,532	74	81	25.50	29.91	+ .07	69.6	+ 2.6	98	7	87	45	18	52	43	51	36	36	0.10	− 0.2	2	5,340	w.	32	w.	16	27	4	0	1.1	0.0	0.0
Tonopah	6,090	12	20	24.13	29.92		72.1		94	6	84	53	31	60	28	53	37	34	0.94	+ 0.6	5	6,522	se.	28	nw.	10	18	13	0	3.0	0.0	0.0
Winnemucca	4,344	18	56	25.63	29.94	+ .06	69.8	− 1.0	95	7	89	44	25	51	46	49	33	31	0.16	0.0	2	4,406	sw.	43	s.	11	25	6	0	1.5	0.0	0.0
Modena	5,479	10	43	24.69	29.93	+ .07	68.4	− 0.2	95	5	83	47	18	54	39	53	43	50	2.44	+ 0.6	12	7,418	sw.	60	sw.	11	15	12	4	3.7	0.0	0.0
Salt Lake City	4,360	163	203	25.66	29.94	+ .03	74.6	− 0.9	93	4	86	57	16	64	30	58	47	42	0.82	0.0	8	5,574	se.	46	se.	14	14	12	5	4.2	0.0	0.0
Grand Junction	4,602	60	68	25.46	29.99	+ .09	73.0	− 3.1	95	4	85	56	16	61	34	59	52	56	3.65	+ 2.6	13	3,919	se.	34	w.	4	9	15	7	5.2	0.0	0.0
Northern Plateau.							**71.9**	**+ 1.4**										**42**	**0.42**	**0.0**										**3.2**		
Baker	3,471	48	53	26.45	29.97	+ .02	66.2	+ 1.3	92	30	83	41	5	50	44	52	40	46	0.18	− 0.2	5	4,063	se.	26	ne.	12	17	12	2	3.3	0.0	0.0
Boise	2,739	78	86	27.12	29.90	− .03	74.0	+ 2.2	97	11	89	52	19	59	37	56	43	37	0.34	+ 0.2	2	3,439	se.	32	ne.	1	22	8	1	2.1	0.0	0.0
Lewiston	757	40	48	29.14	29.93	− .02	74.9	+ 1.4	102	13	91	48	25	58	45				0.07	− 0.3	3	2,671	e.	25	w.	14	17	10	4	3.3	0.0	0.0
Pocatello	4,477	60	68	25.51	29.93	+ .01	71.3	+ 0.8	93	8	84	50	16	58	35	54	42	41	0.33	− 0.2	4	6,030	se.	48	sw.	12	13	13	5	4.5	0.0	0.0
Spokane	1,929	101	110	27.93	29.93	− .02	70.2	+ 2.3	95	8	84	47	25	56	38	56	45	46	1.02	+ 0.5	6	4,574	sw.	39	sw.	14	17	12	2	2.5	0.0	0.0
Walla Walla	991	57	65	28.88	29.94	− .02	74.6	+ 0.8	100	7	88	54	26	62	35	57	44	38	0.57	+ 0.1	4	3,436	s.	24	sw.	14	21	10	0	2.3	0.0	0.0
North Pacific Coast Region.							**61.5**	**− 0.4**										**78**	**1.29**	**+ 0.5**										**5.3**		
North Head	211	11	56	29.86	30.08	+ .05	56.4	− 1.5	65	18	60	50	12	53	10	55	55	94	1.08	+ 0.5	10	11,018	n.	46	s.	17	9	12	10	6.1	0.0	0.0
Port Angeles	29	8	53	30.06	30.09		56.6		74	7	64	44	12	49	23				0.70	0.0	11	4,262	nw.	25	w.	1	9	11	11	5.6	0.0	0.0
Seattle	125	215	250	29.94	30.07	+ .07	62.0	− 1.1	80	12	70	50	22	54	26	56	52	74	1.61	+ 1.1	7	5,092	n.	34	s.	31	10	12	9	5.3	0.0	0.0
Tacoma	213	113	120	29.86	30.08	+ .06	62.2	− 0.8	81	12	71	47	22	53	28				1.18	+ 0.5	7	3,806	n.	20	w.	31	3	21	7	6.1	0.0	0.0
Tatoosh Island	86	7	57	29.97	30.07	+ .07	53.6	− 1.7	60	7	56	48	11	51	12	53	52	95	4.12	+ 2.0	16	7,597	s.	36	s.	17	3	6	22	7.9	0.0	0.0
Yakima	1,071	4																																
Medford	1,425	4					71.0		102	6	90	44	25	52	50				0.00		0		nw.				19	10	2		0.0	0.0
Portland, Oreg.	153	68	106	29.88	30.04	+ .03	67.0	+ 1.1	90	7	78	50	4	57	27	58	53	65	0.30	− 0.4	4	4,342	nw.	21	nw.	7	16	10	5	4.1	0.0	0.0
Roseburg	510	9	57	29.48	30.02	+ .02	67.6	+ 1.4	95	7	83	43	24	53	40	58	51	63	0.04	− 0.3	1	2,535	n.	16	sw.	17	22	8	1	2.0	0.0	0.0
Middle Pacific Coast Region.							**64.0**	**− 0.7**										**66**	**0.00**	**0.0**										**3.5**		
Eureka	62	73	89	30.00	30.07	+ .07	55.8	0.0	70	17	60	48	4	52	16	53	51	88	0.01	− 0.1	1	3,934	nw.	24	n.	24	6	10	15	6.3	0.0	0.0
Mount Tamalpais	2,375	11	18																															
Point Reyes Light	490	7	18	29.44	29.96		53.7	− 0.8	62	4	57	46	29	50	13				0.00		0	16,036	nw.	48	nw.	14	3	8	20	7.5	0.0	0.0
Red Bluff	332	50	56	29.54	29.88	+ .02	77.5	− 3.5	106	6	93	54	12	62	40	60	46	37	0.00	0.0	0	3,015	se.	17	se.	16	29	2	0	0.4	0.0	0.0
Sacramento	69	106	117	29.84	29.91	+ .06	72.1	0.0	101	5	89	48	13	56	41	60	52	56	0.00	0.0	0	6,116	s.	21	s.	17	31	0	0	0.2	0.0	0.0
San Francisco	155	208	243	29.81	29.98	+ .06	59.6	+ 1.6	77	15	65	51	3	54	20	54	52	84	0.00	0.0	0	7,596	sw.	36	w.	20	15	8	8	4.6	0.0	0.0
San Jose	141	12	110	29.85	30.00		65.3	− 1.4	90	15	80	43	27	51	41				0.00	0.0	0	4,217	nw.	20	nw.	15	26	5	0	2.0	0.0	0.0
South Pacific Coast Region.							**70.9**	**− 0.3**										**66**	***T.***	**0.0**										**2.0**		
Fresno	327	89	98	29.54	29.88	+ .06	79.9	− 1.3	104	4	97	57	12	63	37	59	41	32	0.00	0.0	0	6,149	nw.	22	nw	16	30	1	0	0.3	0.0	0.0
Los Angeles	338	159	191	29.58	29.94	+ .06	70.6	− 0.9	90	28	80	55	12	61	25	62	58	74	T.	0.0	0	3,566	sw.	15	sw.	1	27	3	1	2.2	0.0	0.0
San Diego	87	62	70	29.84	29.93	+ .04	68.2	− 0.5	81	28	73	60	18	63	15	64	62	83	T.	0.0	0	4,492	w.	18	nw.	2	19	11	1	3.4	0.0	0.0
San Luis Obispo	201	32	40	29.76	29.98	+ .04	65.0	+ 1.5	86	27	78	47	25	52	35	56	52	77	0.00	0.0	0	2,478	nw.	15	nw.	12	27	4	0	2.1	0.0	0.0
West Indies.																																		
San Juan, P. R.	82	8	54	29.93	30.01		79.4		88	22	83	73	25	75	13				5.89	− 1.5	22	10,764	e.	37	e.	3	8	19	4	4.5	0.0	0.0
Panama Canal.																																		
Balboa Heights	118	7	97	29.73	29.85	+ .01	80.6	+ 0.4	92	3	87	72	1	74	16	75	74	87	9.51	+ 1.5	19	4,384	nw.	26	nw.	21	0	15	16	7.4	0.0	0.0
Colon	36	7	97	29.82	29.86	.00	80.6	+ 0.7	89	19	86	72	11	75	15	76	75	85	18.45	+ 3.4	29	6,403	n.	27	sw.	29	0	7	24	8.4	0.0	0.0
Alaska.																																		
Juneau	80	11	49				54.3		75	23	61	42	31	48	29	51	50	90	7.94		19	2,160	s.	14	se.	2	9	1	21	73	0.0	0.0

TABLE II.—*Data furnished by the Canadian Meteorological Service, August, 1921.*

Stations.	Altitude above mean sea level, Jan. 1, 1919.	Pressure.			Temperature of the air.						Precipitation.		
		Station reduced to mean of 24 hours.	Sea level reduced to mean of 24 hours.	Departure from normal.	Mean max.+mean min.÷2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*Inches.*	*Inches.*	*Inches.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	125												
Sydney, C. B. I.	48	29.98	30.02	+0.07	61.8	−1.5	72.2	51.5	83	42	0.78	−2.84	0.0
Halifax, N. S.	88	29.92	30.02	− .06	62.0	−1.6	72.3	51.7	80	45	2.51	−1.84	0.0
Yarmouth, N. S.	65	29.96	30.03	− .06	59.2	−1.0	67.2	51.1	75	44	2.28	−1.73	0.0
Charlottetown, P. E. I.	38	29.94	29.98	+ .04	62.6	−1.7	70.8	54.3	80	46	2.83	−0.91	0.0
Chatham, N. B.	28	29.96	29.99	+ .06	61.7	−1.5	72.1	51.4	86	43	7.23	+3.19	0.0
Father Point, Que.	20	29.92	29.94	+ .03	54.9	−0.7	63.4	46.4	78	38	4.38	+1.33	0.0
Quebec, Que.	296	29.69	30.01	+ .08	63.0	−0.1	71.8	54.1	83	46	3.66	−0.17	0.0
Montreal, Que.	187	29.80	30.00	+ .05	66.9	+0.5	75.7	58.3	86	50	3.55	−0.02	0.0
Stonecliffe, Ont.	489	29.41	30.01	+ .05	63.0	−0.2	75.6	50.4	92	42	1.61	−1.34	0.0
Ottawa, Ont.	236	29.77	30.03	+ .07	66.9	+2.1	78.9	55.0	88	46	2.68	−0.35	0.0
Kingston, Ont.	285	29.73	30.03	+ .05	68.2	+1.2	75.8	60.6	84	52	2.14	−0.24	0.0
Toronto, Ont.	379	29.64	30.03	+ .04	68.0	+2.0	78.4	57.6	91	47	2.07	−0.69	0.0
Cochrane, Ont.	930												
White River, Ont.	1,244	28.67	29.97	+ .01	56.4	0.0	71.0	41.8	84	30	2.14	−1.16	0.0
Port Stanley, Ont.	592	29.40	30.03	+ .03	65.7	−0.2	74.8	56.7	88	40	2.26	−0.16	0.0
Southampton, Ont.	656	29.32			64.8	−1.0	73.6	56.1	82	44	1.52	−0.73	0.0
Parry Sound, Ont.	688	29.34	30.02	+ .04	65.5	+2.0	76.5	54.6	84	43	2.76	+0.04	0.0
Port Arthur, Ont.	644	29.29	30.00	+ .04	61.8	+2.3	73.1	50.6	92	42	0.35	−2.40	0.0
Winnipeg, Man.	760	29.11	29.93	− .01	64.0	+0.6	76.3	51.8	94	42	2.46	−0.21	0.0
Minnedosa, Man.	1,690	28.15	29.93	− .01	62.5	+3.1	75.9	49.1	91	34	3.70	+1.60	0.0
Le Pas, Man.	860												
Qu'Appelle, Sask.	2,115	27.70	29.91	− .02	62.1	+0.6	76.0	48.3	94	31	1.54	−0.10	0.0
Medicine Hat, Alb.	2,144												
Moose Jaw, Sask.	1,759												
Swift Current, Sask.	2,392	27.41	29.98	+ .05	65.6	+1.6	82.0	49.3	98	41	1.22	−0.69	0.0
Calgary, Alb.	3,428												
Banff, Alb.	4,521												
Edmonton, Alb.	2,150												
Prince Albert, Sask.	1,450	28.37	29.92	.00	61.1	+2.2	75.0	47.3	86	36	1.34	−0.81	0.0
Battleford, Sask.	1,592	28.18	29.90	− .01	62.8	+0.2	78.1	47.5	93	40	1.02	−1.34	0.0
Kamloops, B. C.	1,262	28.71	29.98	+ .07	67.6	+1.0	79.9	55.3	96	45	0.84	−0.25	0.0
Victoria, B. C.	230	29.79	30.04	+ .03	58.4	−0.3	65.8	50.9	76	48	0.85	+0.25	0.0
Barkerville, B. C.	4,180	25.70	29.99	+ .09	50.7	−5.6	61.1	40.3	74	33	4.15	+1.05	0.0
Triangle Island, B. C.	680												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	29.99	30.15	+ .05	79.8	+0.2	85.9	73.7	89	69	4.75	−1.33	0.0

LATE REPORTS.

JULY, 1921.

St. Johns, N. F.	125	29.76	29.89	−0.08	59.9	+0.6	69.9	50.0	86	40	1.79	−2.10	0.0
Father Point, Que.	20	29.87	29.89	+ .05	60.4	+2.8	71.1	49.8	84	41	2.60	−0.44	0.0
Medicine Hat, Alb.	2,144	27.62	29.82	− .08	71.4	+3.6	86.3	56.6	101	45	1.85	−0.24	0.0
Calgary, Alb.	3,428	26.46	29.96	+ .06	63.8	+3.2	80.3	47.3	95	36	2.07	−0.61	0.0
Banff, Alb.	4,521	25.42	29.91	+ .01	57.5	+0.9	72.4	42.6	86	33	1.28	−1.96	0.0
Kamloops, B. C.	1,262	28.76	30.03	+ .09	69.0	+0.5	83.3	54.8	94	44	0.23	−1.38	0.0
Barkerville, B. C.	4,180	25.75	30.04	+ .13	52.2	−2.9	63.8	40.6	73	29	2.55	−0.47	0.0
St. Johns, N. F. (Mar., 1921)	125	29.82	29.96	+ .08	28.0	+0.3	35.3	20.7	52	8	2.97	+2.10	8.0

SEISMOLOGICAL REPORTS FOR AUGUST, 1921.

W. J. HUMPHREYS, Professor in Charge.

[Weather Bureau, Washington, Oct. 3, 1921.]

TABLE 1.—*Noninstrumental earthquake reports, August, 1921.*

Day.	Approximate time, Greenwich civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA.								
1921	H. m.		° ′	° ′			M. s.			
9	13 43	Calexico	32 41	115 30	2	1	½	Faint	Felt by several	W. S. Pratt.
	13 46	do	32 41	115 30	2	1	½	do	do	Do.
	20 46	do	32 41	115 30	3	1	3	do	do	Do.
10	19 06	Julian	33 05	116 37	4-5	1	8	Loud	Felt by many	J. H. L. Vogt.
	21 51	do	33 05	116 37	5	1	6	Rumbling	do	Do.
29	2 05	Eureka	40 45	124 15	3	2	Few	None	do	L. B. Cooper.
		VIRGINIA.								
7	6 30	Buckingham	37 35	78 35		1		Rumbling		Cora L. Jones.
		Columbia	37 45	78 10	2	1	1	do		E. A. Richardson.
		Covesville	37 50	78 50	4	1	30	do	Felt by several	Mrs. M. R. Wright.
		Dillwyn	37 40	78 30		1		do	Felt by many	Postmaster.
		Warren	37 45	78 40	5?	1			do	J. C. Anderson.
	6 40	New Canton	37 40	78 20	4	1	Few		do	W. P. Moorman.
		Scottsville	37 45	78 30	5	3	½-2	Rumbling	Felt for 10 miles around	C. S. Turner.

TABLE 2.—*Instrumental seismological reports, August, 1921.*

Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.

[For significance of symbols, see REVIEW for January, 1921, p. 47.]

ALASKA. *U. S. C. & G. S. Magnetic Observatory, Sitka.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 23	.....	L_E	20 42 32	23	.....	.....	.....	No record on NS.
		M_E	20 43 32	.....	10	.....	.....	
		C_E	20 45 04	.....	.....	.....	.....	
		F_E	20 54 —	.....	.....	.....	.....	

ARIZONA. *U. S. C. & G. S. Magnetic Observatory, Tucson.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 23	.....	L_E	20 42 57	25	.....	.....	.....	Wind tremors obscure record on NS; L_E doubtful.
		M_E	20 51 35	15	10	.....	.....	
		C_E	20 52 38	15	.....	.....	.....	
		F_E	21 07 —	12	.....	.....	.....	
29	.....	P_E	18 56 12	3	.....	.....	.....	NS component out of order.
		L_E	18 57 02	9	.....	.....	.....	
		M_E	18 57 31	7	20	.....	.....	
		C_E	18 58 05	8	.....	.....	.....	
		F_E	19 03 —	.....	.....	.....	.....	

CALIFORNIA. *Theosophical University, Point Loma.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 12	.....	.....	.....	.....	150	200	.....	Tremors during preceding 24 hours.
13	.....	.....	.....	.....	100	100	.....	
14	.....	.....	.....	.....	100	100	.....	
16	.....	.....	.....	.....	100	100	.....	
17	.....	.....	.....	.....	50	50	.....	
18	.....	.....	.....	.....	50	50	.....	
30	.....	.....	.....	.....	100	100	.....	

DISTRICT OF COLUMBIA. *U. S. Weather Bureau, Washington.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 19	.....	P?	8 36 18	.....	.....	.....	.....	
		L?	8 37 45	.....	.....	.....	.....	
		F	8 50 —	.....	.....	.....	.....	
23	.....	P	20 25 04	.....	.....	.....	4500	
		S?	20 31 20	.....	.....	.....	.....	
		eL	20 37 —	.....	.....	.....	.....	
		L	20 42 —	16	.....	.....	.....	
		F	21 15 —	.....	.....	.....	.....	
29	.....	e	19 09 —	.....	.....	.....	.....	
		F	19 16 —	.....	.....	.....	.....	

HAWAII. *U. S. C. & G. S. Magnetic Observatory, Honolulu.*

Date.	Character.	Phase.	Time.	Period T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 9	.....	L_E	11 01 20	24	.....	.....	.....	
		L_N	11 01 25	25	.....	.....	.....	
		M_E	11 03 25	21	*400	.....	.....	
		M_N	11 03 30	21	.....	*400	.....	
		F_E	11 06 ..	.....	.....	.....	.....	
		F_N	11 07 ..	.....	.....	.....	.....	
17	.....	P_E	23 55 40	.....	.....	.....	.....	
		P_N	23 55 33	.....	.....	.....	.....	
18	.....	L_E	0 01 20	6	.....	.....	.....	
		M_E	0 02 30	7	*2,100	.....	.....	
		M_N	0 02 37	6	.....	*1,600	.....	
		C	0 06 ..	.....	.....	.....	.....	
		F_E	0 29 ..	.....	.....	.....	.....	
		F_N	0 49 ..	.....	.....	.....	.....	
22	.....	L_E	4 29 49	11	.....	.....	.....	
		L_N	4 29 43	12	.....	.....	.....	
		M	4 30 00	.....	*500	*600	.....	
		C_E	4 31 45	.....	.....	.....	.....	
		C_N	4 32 50	.....	.....	.....	.....	
		F_E	4 57 ..	.....	.....	.....	.....	
		F_N	4 50 ..	.....	.....	.....	.....	
23	.....	P	20 41 05	10	.....	.....	.....	
		S_E	20 48 58	.....	.....	.....	.....	
		$SR1_E$	20 53 27	.....	.....	.....	.....	
		L_N	21 00 55	26	.....	.....	.....	
		M_E	21 04 19	.....	*500	.....	.....	
		M_N	21 06 57	16	.....	*600	.....	
		C_E	21 09 30	.....	.....	.....	.....	
		C_N	21 10 27	.....	.....	.....	.....	
		F_E	21 19 ..	.....	.....	.....	.....	
		F_N	21 23 ..	.....	.....	.....	.....	
24	.....	e	11 13 28	19	*300	*300	.....	Nothing definite.
		F_E	11 22 ..	.....	.....	.....	.....	
		F_N	11 17 ..	.....	.....	.....	.....	
24	.....	e	11 35 ..	17	*300	*300	.....	Do.
		F	11 46 ..	.....	.....	.....	.....	
29	.....	e_E	19 14 19	.....	*100	.....	.....	Nothing definite.
		e_N	19 13 40	9	.....	*200	.....	
		F	19 17 ..	.....	.....	.....	.....	

* Trace amplitude.

ILLINOIS. *U. S. Weather Bureau, Chicago.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 11	.....	P.....	12 07 22	.....	.....	.....	1,700	
		S.....	12 10 14	.....	.....	.....	.....	
		L?....	12 11 45	.....	.....	.....	.....	
		F.....	12 15 15	.....	.....	.....	.....	
14	.....	eL....	14 13 ..	18*ca*	.....	.....	.....	Heavy micros.
		F.....	15	.....	.....	.....	.....	
15	.....	eL....	15 08 ..	.....	.....	.....	.....	
		L.....	15 14 ..	15	.....	.....	.....	
		F.....	16 *ca* ..	.....	.....	.....	.....	
18	.....	L.....	0 48 ..	15	.....	.....	.....	Previous portion lost during adjustment of instrument.
		F.....	1 20 *ca*	.....	.....	.....	.....	
19	.....	P.....	8 36 13	.....	.....	.....	.....	
		S.....	8 38 20	.....	.....	.....	.....	
		L.....	8 39 12	.....	.....	.....	.....	
		F.....	9 30 *ca*	.....	.....	.....	.....	
21	.....	eL....	1 23 ..	.....	.....	.....	.....	
		L.....	1 30 ..	18	.....	.....	.....	
		F.....	2 *ca* ..	.....	.....	.....	.....	
23	.....	P.....	20 25 30	.....	.....	.....	4,400	
		PR1..	20 27 24	.....	.....	.....	.....	
		S.....	20 31 38	.....	.....	.....	.....	
		L.....	20 35 30	.....	.....	.....	.....	
		M.....	20 44 ..	.....	*4,000	.....	.....	
		F.....	22 10 *ca*	.....	.....	.....	.....	
24	.....	eL....	14 08 15	16	.....	.....	.....	
		F.....	14 35 *ca*	.....	.....	.....	.....	
25	.....	S?....	2 12 09	.....	.....	.....	.....	
		L.....	2 14 30	.....	.....	.....	.....	
		F.....	2 40 ..	.....	.....	.....	.....	
25	.....	e.....	4 07 ..	.....	.....	.....	.....	
		F.....	4 25 ..	.....	.....	.....	.....	
29	.....	P.....	19 05 12	.....	.....	.....	300	
		S.....	19 05 47	.....	.....	.....	.....	
		L.....	19 05 50	.....	.....	.....	.....	
		F.....	19 30 *ca*	.....	.....	.....	.....	

* Trace amplitude.

MARYLAND. *U. S. C. & G. S. Magnetic Observatory, Cheltenham.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 19	.....	e_N....	8 38 10	.....	.....	.....	.....	
		L_E....	8 39 05	.....	.....	.....	.....	
		L_N....	8 38 44	15	.....	.....	.....	
		M_N....	8 39 26	11	.....	10	.....	
		C_N....	8 40 20	10	.....	.....	.....	
		F_E....	8 41 ..	.....	.....	.....	.....	
		F_N....	8 46 ..	.....	.....	.....	.....	
23	.....	e_E....	20 42 35	.....	.....	.....	.....	Nothing definite on EW.
		e_N....	20 37 05	14	.....	.....	.....	
		L_N....	20 41 28	16	.....	.....	.....	
		M_N....	20 42 15	16	.....	30	.....	
		C_E....	20 45 ..	.....	.....	.....	.....	
		C_N....	20 42 58	.....	.....	.....	.....	
		F_E....	20 50 ..	.....	.....	.....	.....	
		F_N....	20 57 ..	.....	.....	.....	.....	

CANAL ZONE. *Panama Canal, Balboa Heights.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 11	.....	.....	.....	.....	.....	.....	.....	Very slight tremors at 10:18, 11:27, 12:01.
13	.....	.....	.....	.....	.....	.....	.....	Very slight tremor at 0:50.

VERMONT. *U. S. Weather Bureau, Northfield.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 23	.....	eL....	20 37 ..	.....	.....	.....	.....	
		F.....	20 50 ..	.....	.....	.....	.....	

CANADA. *Dominion Observatory, Ottawa.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
Aug. 14	.....	e_E....	13 39 38	.....	.....	.....	.....	
		eL_E...	14 02 ..	.....	.....	.....	.....	
		L_E....	14 08 ..	21	.....	.....	.....	
		F.....	15 00 ..	.....	.....	.....	.....	
16	.....	e_E....	18 24 12	.....	.....	.....	.....	Press report quake on coast of Red Sea.
		F.....	18 30 ..	.....	.....	.....	.....	
17	.....	eL_E?..	(23 47 18)	.....	.....	.....	.....	
		L?....	23 52 24	.....	.....	.....	.....	
18	.....	F.....	1 00 ..	.....	.....	.....	.....	
19	.....	e_E....	8 37 19	.....	.....	.....	.....	
		eL_E...	8 40 30	.....	.....	.....	.....	
		L.....	8 42 ..	13	.....	.....	.....	
		L.....	8 43 ..	9	.....	.....	.....	
		F.....	9 03 ..	.....	.....	.....	.....	
21	.....	e_E....	1 21 48	.....	.....	.....	.....	Micros obscure NS.
		eL_E...	1 26 ..	20	.....	.....	.....	
		F.....	1 31 ..	.....	.....	.....	.....	
23	.....	O.....	20 17 29	.....	.....	.....	3,910	
		P.....	20 24 40	.....	.....	.....	.....	
		PR2..	20 26 04	.....	.....	.....	.....	
		S_N....	20 30 24	.....	.....	.....	.....	
		S_E....	20 30 22	.....	.....	.....	.....	
		eL....	20 34 ..	.....	.....	.....	.....	
		L.....	20 37 ..	21	.....	.....	.....	
		L_E....	20 38 ..	20	.....	.....	.....	
		L.....	20 40 ..	13	.....	.....	.....	
		L.....	20 53 ..	9	.....	.....	.....	
		F.....	21 45 ..	.....	.....	.....	.....	
25	.....	e.....	2 19 43	.....	.....	.....	.....	Micros obscure NS.
		L_E....	2 24 ..	.....	.....	.....	.....	
		F.....	2 35 ..	.....	.....	.....	.....	
25	.....	e.....	4 08 07	.....	.....	.....	.....	
		e?.....	4 10 27	.....	.....	.....	.....	
		eL_E...	4 14 ..	.....	.....	.....	.....	
		F.....	4 23 ..	.....	.....	.....	.....	
27	.....	O.....	8 12 14	.....	.....	.....	220	Local quake; good vertical record.
		P_V....	8 12 47	.....	.....	.....	.....	
		S.....	8 13 11	.....	.....	.....	.....	
		F.....	8 14 16	.....	.....	.....	.....	
29	.....	e?e....	19 05 47	.....	.....	.....	.....	
		eL....	19 10 40	.....	.....	.....	.....	
		L.....	19 11 ..	11	.....	.....	.....	
		F.....	19 25 ..	.....	.....	.....	.....	

No earthquakes were recorded at the following stations during August, 1921:

COLORADO. *Regis College*, Denver.
PORTO RICO. *U. S. C. & G. S. Magnetic Observatory*, Vieques.

The following station was closed during August, 1921:

NEW YORK. *Fordham University*, New York.

Reports for August, 1921 have not been received from the following stations:

ALABAMA. *Spring Hill College*, Mobile.
DISTRICT OF COLUMBIA. *Georgetown University*, Washington.
MASSACHUSETTS. *Harvard University*, Cambridge.
MISSOURI. *St. Louis University*, St. Louis.
NEW YORK. *Canisius College*, Buffalo; *Cornell University*, Ithaca.
CANADA. *Dominion Meteorological Service*, Toronto *and* Victoria.

TABLE 3. *Late reports (instrumental).*

DISTRICT OF COLUMBIA. *Georgetown University, Washington.*

1921.			H. m. s.	Sec.	μ	μ	Km.	
July 4	.....	e.....	14 35 45	.....	.....	.....	.....	Micros.
		S_E....	14 41 37	.....	.....	.....	.....	
		S_N....	14 41 36	.....	.....	.....	.....	
		F.....	15 *ca.*	.....	.....	.....	.....	
8	.....	e.....	10 56 ..	.....	.....	.....	.....	Heavy micros.
		S_E?....	10 58 23	.....	.....	.....	.....	
		eL_E?..	11 01 00	11	.....	.....	.....	
		eL_N?..	11 01 06	11	.....	.....	.....	
		F.....	11 15 ..	.....	.....	.....	.....	
9	.....	e_E....	7 09 56	.....	.....	.....	.....	
		e_N....	7 10 18	.....	.....	.....	.....	
		F.....	7 16 ..	.....	.....	.....	.....	
12	.....	e.....	20 21 38	.....	.....	.....	.....	

Chart I. Hydrographs of Several Principal Rivers, August, 1921.

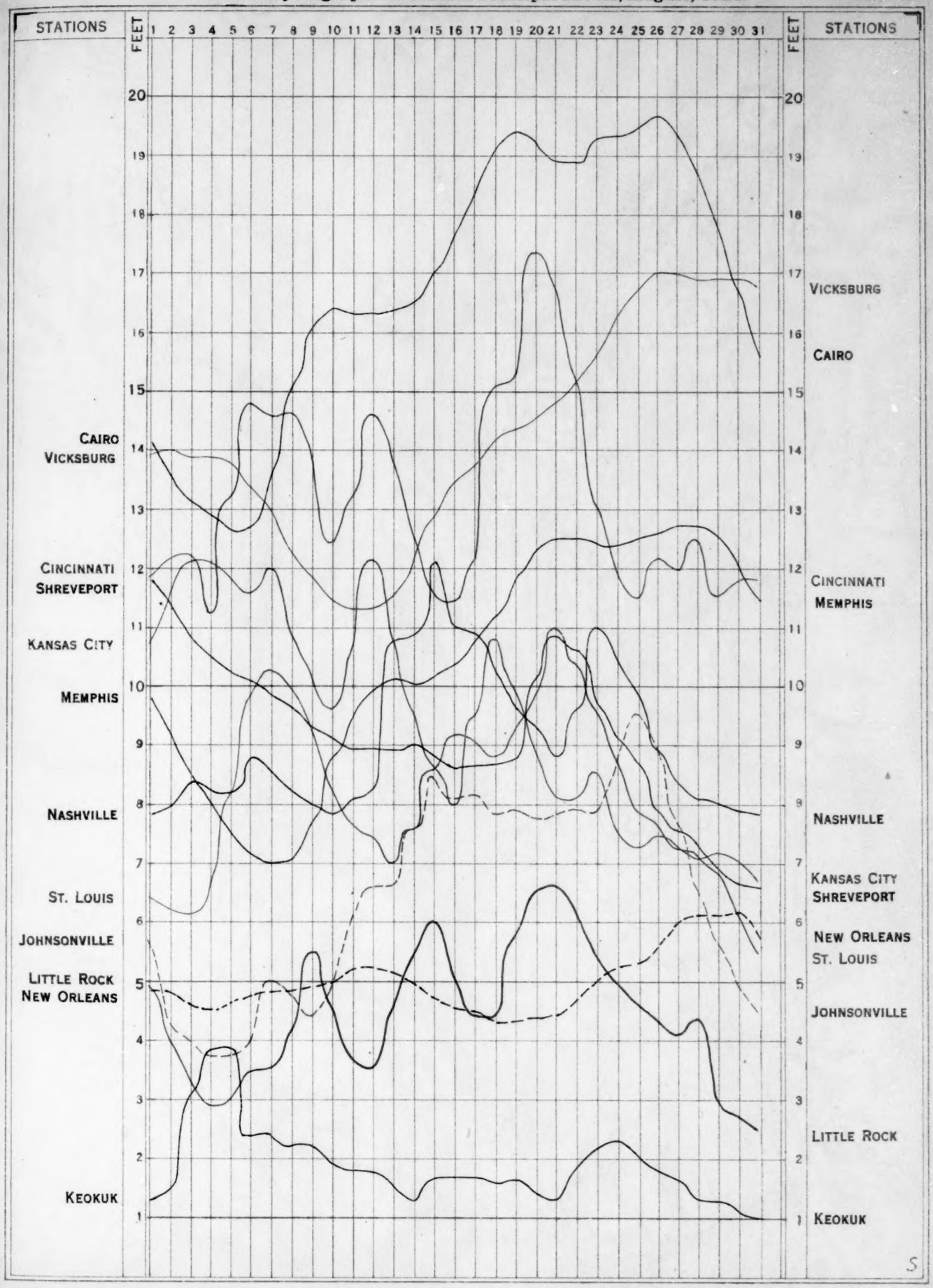


Chart II. Tracks of Centers of High Areas, August, 1921.

(Plotted by Wilfred P. Day.)

I
II
III
IV
V
VI
VII
VIII
VI & VII A
VI & VII B
Barkerville
Prince Albert
Battleford
Calgary
Edmonton
Winnipeg
Minneapolis
St. Paul
Duluth
Sault Ste. Marie
Toronto
Buffalo
Detroit
Chicago
Cleveland
Pittsburgh
Boston
New York
Philadelphia
Atlantic City
Cape May
Sandy Hook
Portland
Seattle
Spokane
Helena
Billings
Miles City
Bismarck
Pierre
Rapid City
Huron
Sioux City
Omaha
Des Moines
Lincoln
North Platte
Denver
Cheyenne
Salt Lake City
Grand Junction
Leadville
Pueblo
Dodge City
Wichita
Kansas City
St. Louis
Springfield
Concordia
St. Joseph
Hannibal
Indianapolis
Columbus
Cincinnati
Louisville
Evansville
Lexington
Richmond
Norfolk
Roanoke
Charlottesville
Staunton
Lynchburg
Petersburg
Raleigh
Wilmington
Charleston
Savannah
Augusta
Atlanta
Columbia
Charlotte
Nashville
Knoxville
Chattanooga
Memphis
Corinth
Birmingham
Anniston
Montgomery
Macon
Meridian
Vicksburg
Jackson
Mobile
Pensacola
Jacksonville
Tallahassee
Thomasville
Tampa
Key West
Miami
Nassau
Bermuda
Havana
Cienfuegos
Santiago de Cuba
Port Arthur
Fort William
Parry Sound
Sudbury
Sault Ste. Marie
Marquette
Escanaba
Green Bay
Milwaukee
Grand Haven
Grand Rapids
Lansing
Erie
Toledo
Scranton
Albany
Syracuse
Rochester
Buffalo
Kingston
Montreal
Quebec
Father Point
Chatham
Yarmouth
Halifax
Amherst
Point
Block Island
Nantucket
Portland
Eastport
Bar Harbor
Bangor
Portland
Boston
Provincetown
Nantucket
Block Island
Sandy Hook
Atlantic City
Cape May
Hatteras
Cape Henry
Norfolk
Roanoke
Charlottesville
Staunton
Lynchburg
Petersburg
Richmond

Chart III. Tracks of Centers of Low Areas, August, 1921.

(Plotted by Wilfred P. Day.)

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, August, 1921.

Chart V. Total Precipitation, Inches, August, 1921.

Chart V. Total Precipitation, Inches, August, 1921.

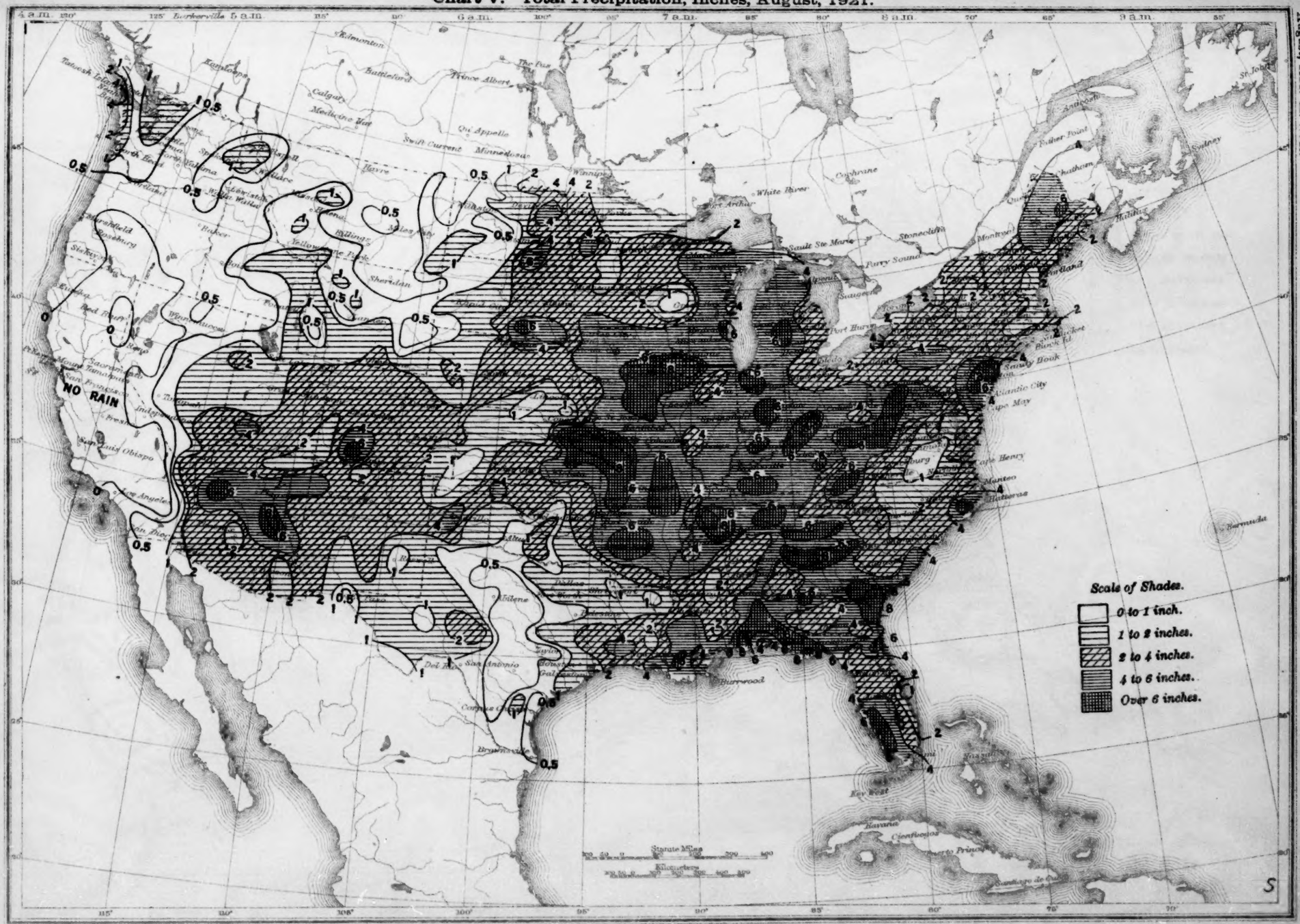


Chart VI. Percentage of Clear Sky between Sunrise and Sunset, August, 1921.

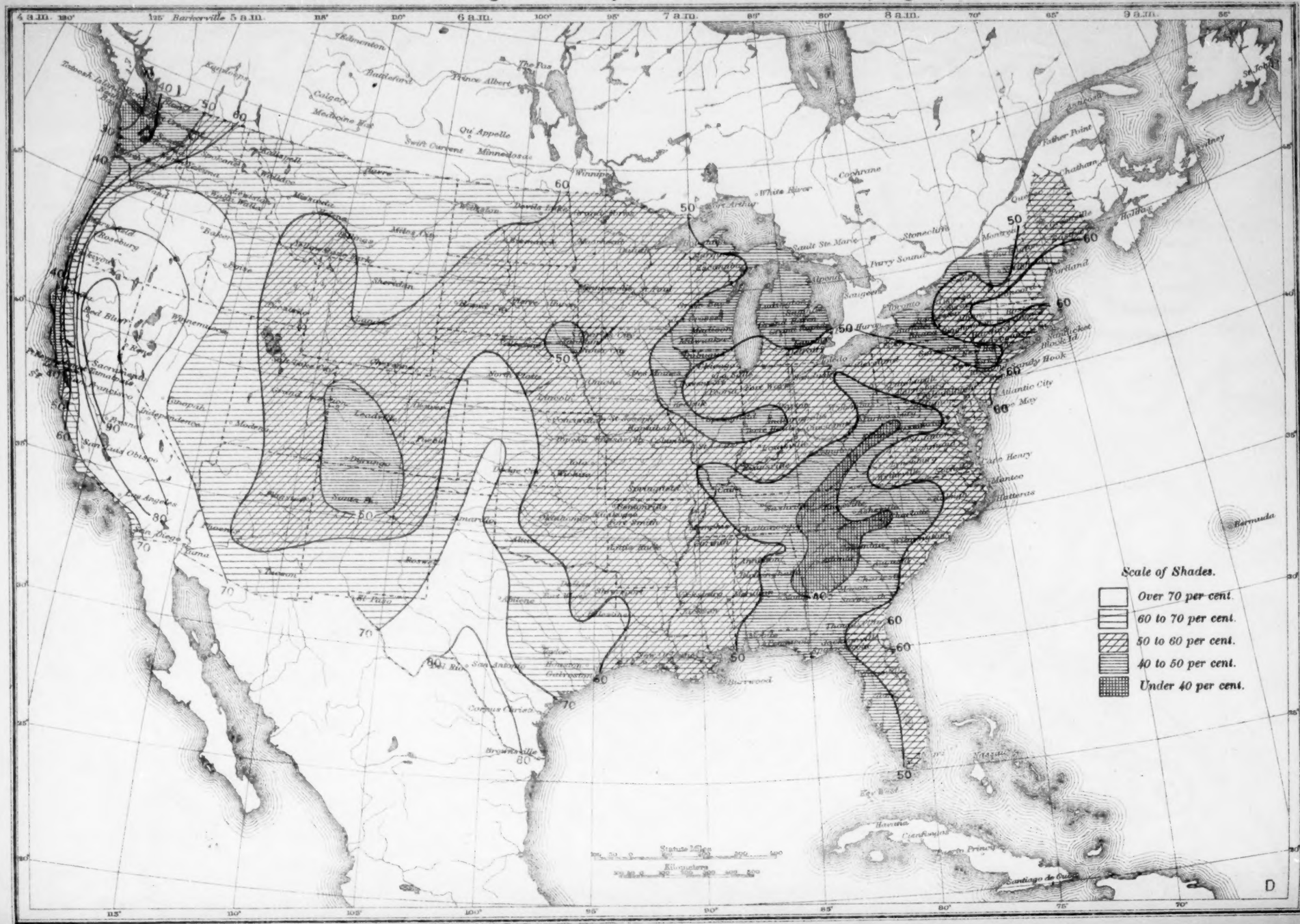


Chart VII. Isobars at Sea-level and Isotherms at Surface; Prevailing Winds, August, 1921.

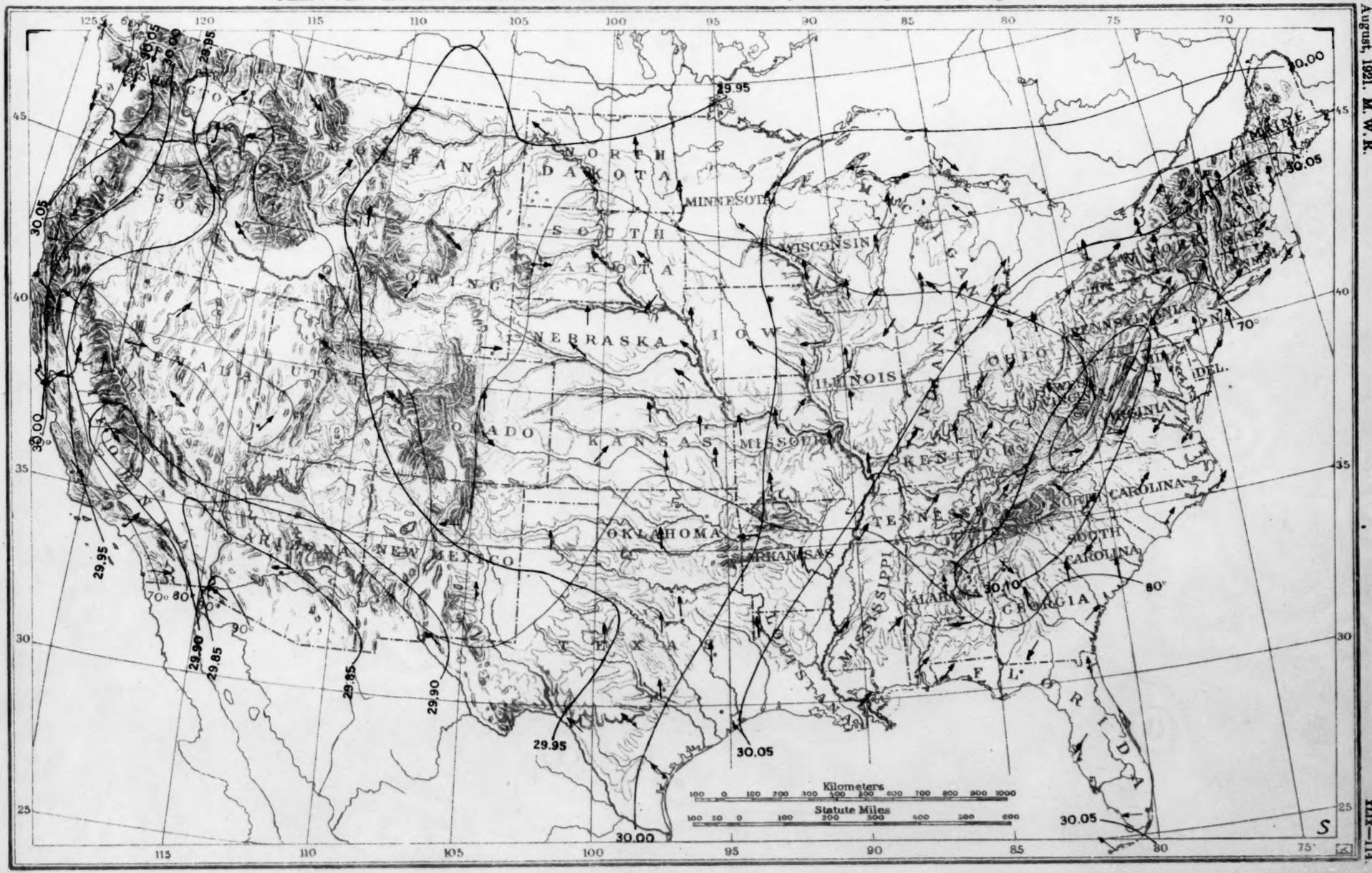
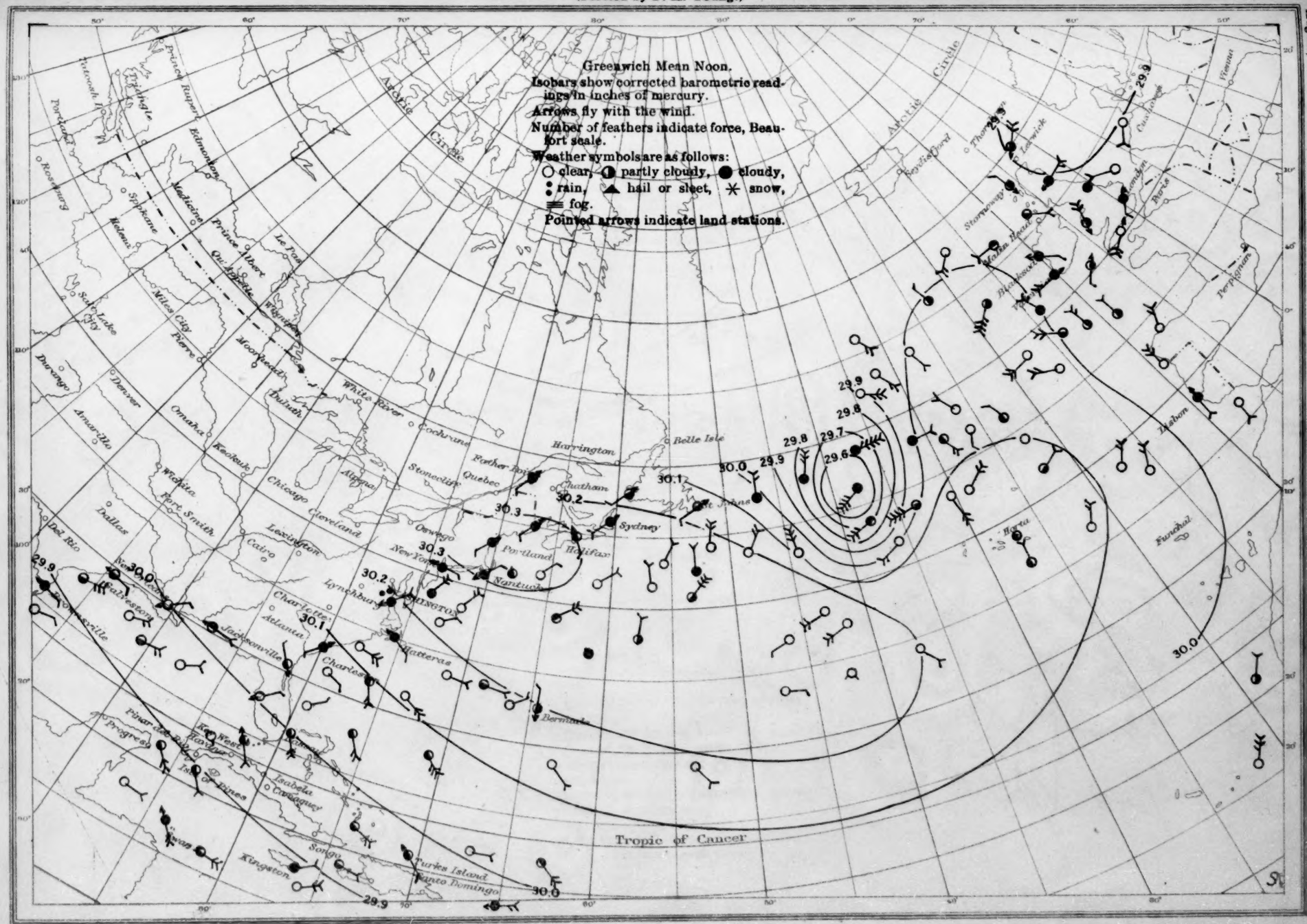


Chart IX. Weather Map of North Atlantic Ocean, August 28, 1921.
(Plotted by F. A. Young.)

Chart IX. Weather Map of North Atlantic Ocean, August 28, 1921.

(Plotted by F. A. Young.)



August, 1921. M. W. R.

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Chart X. Weather Map of North Atlantic Ocean, August 29, 1921.

(Plotted by F. A. Young.)

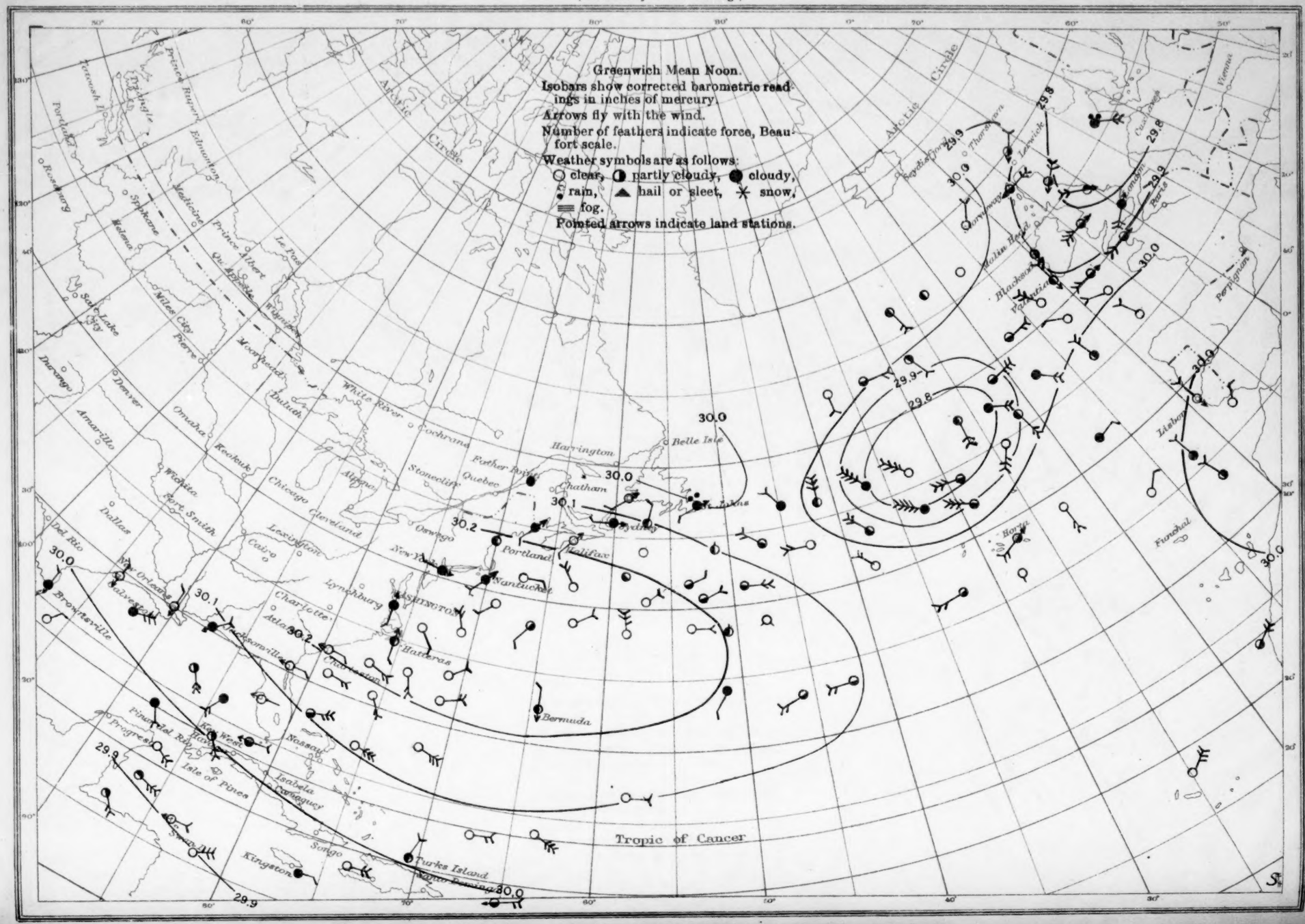


Chart XI. Weather Map of North Atlantic Ocean, August 30, 1921.

Chart XI. Weather Map of North Atlantic Ocean, August 30, 1921.

(Plotted by F. A. Young.)

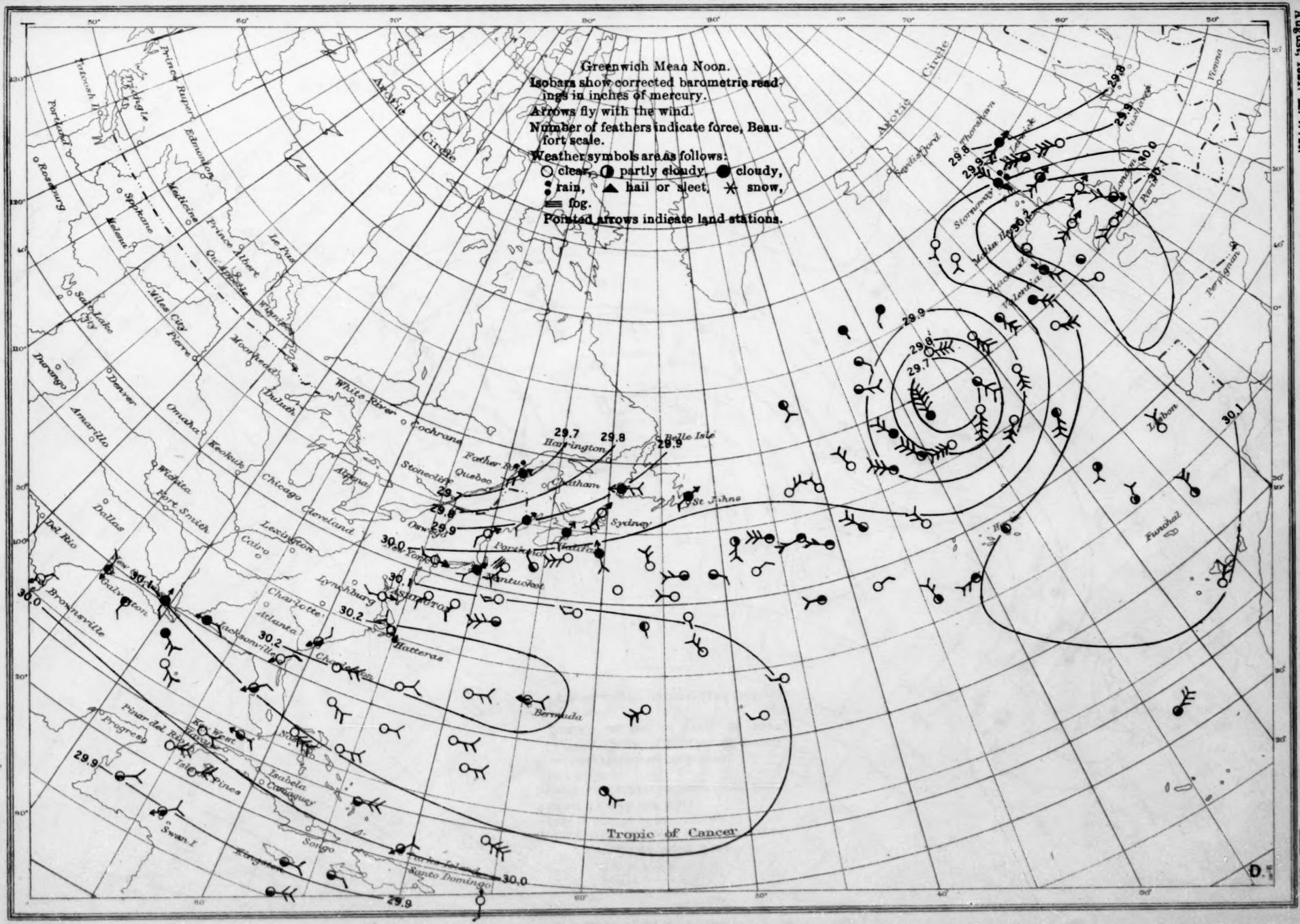
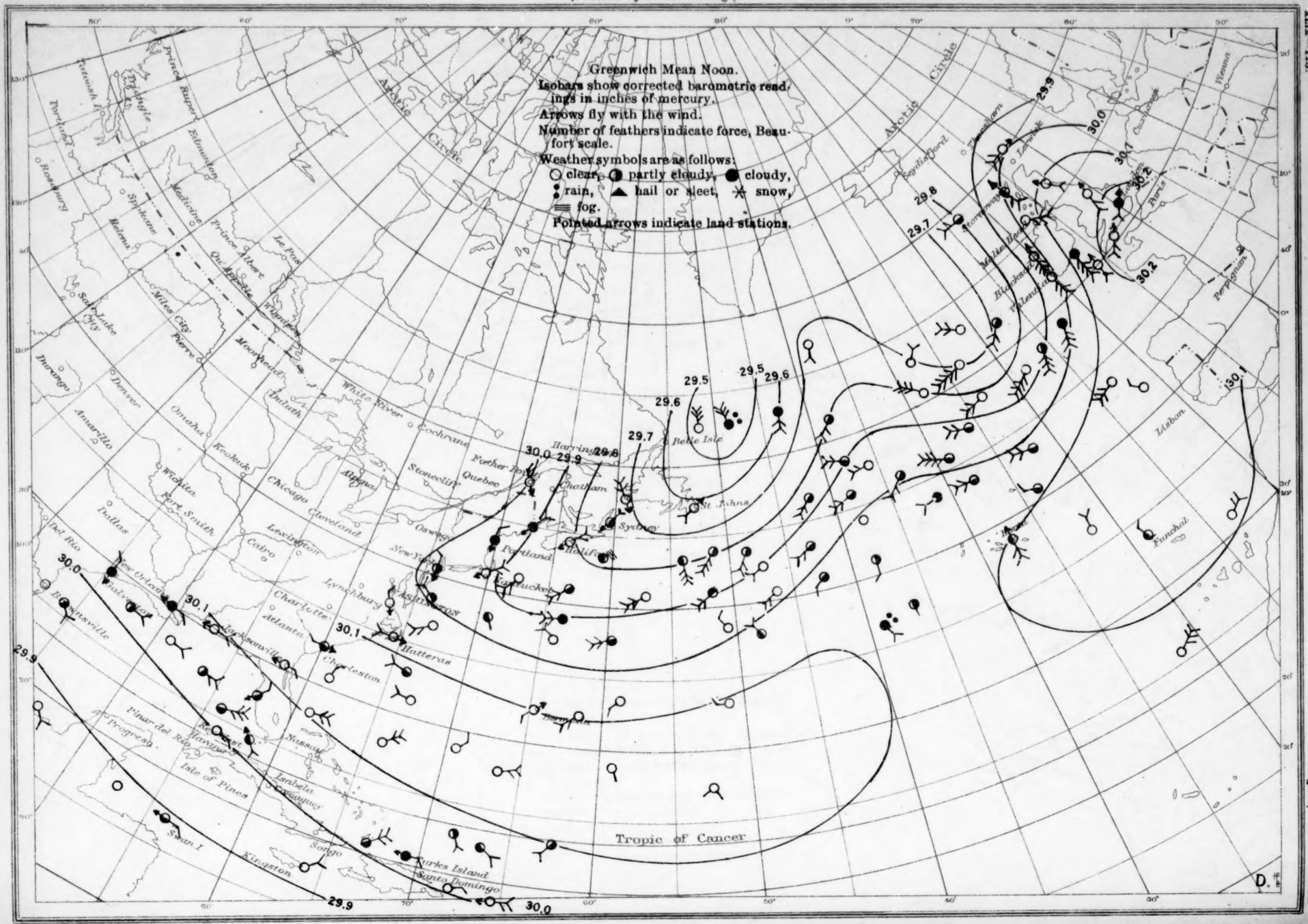


Chart XII. Weather Map of North Atlantic Ocean, August 31, 1921.

(Plotted by F. A. Young.)



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AUGUST, 1921.

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